FOURTH BIENNIAL REPORT

OF THE

State Board of Health of Montana

FIRST BIENNIAL REPORT

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State Registrar of Births and Deaths

Report of Dr. H. T. Ricketts Relative to the Investigation into the Cause and Prevention of Spotted Fever n the Bitter Root Valley.

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DEPARTMENT OF PUBLIC HEALTH OF THE STATE OF MONTANA.

OFFICE OF THE SECRETARY.

Helena, Mont., December 19, 1908.

Hon. Edwin L. Norris, Governor,

Helena, Mont.

Sir: In compliance with the provisions of the Laws of Montana, I hand you herewith the report of the State Board of Health of Montana, the report of the secretary of said board as State Registrar of Births and Deaths, and the report of Dr. H. T. Ricketts relative to the investigation into the cause and prevention of spotted fever. Respectfully Submitted,

THOMAS D. TUTTLE, M. D., Secretary.

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MEMBERSHIP OF THE MONTANA STATE BOARD OF HEALTH.

Hon. Edwin L. Norris, Governor, Helena.
Hon. A. J. Galen, Attorney General, Helena.
Wm. Treacy, M. D., President, Helena.
L. C. Bruning, M. D., Miles City.
H. H. Hanson, M. D., Butte.
M. E. Knowles, D. S. V., Helena.
T. D. Tuttle, M. D., Secretary, Helena.

In Memoriam.

On January 12, 1908, death claimed a member of our Board in the person of Dr. L. C. Bruning of Miles City. Dr. Bruning was not only a highly respected member of the medical profession of Montana, but was an enthusiastic adherent of sanitary principles and the prevention of diseases among the people of his State. He never hesitated at any time to devote his time and energy to this work and was fearless in the advancement of any idea which he believed would be of benefit to the people of his locality and of the State.

Introduction.

This report embraces in reality four reports, namely—the report of the State Board of Health, as required under the provisions of Chapter 110, Session Laws 1907; the report of the State Registrar of Births and Deaths, as provided for in Chapter 25, Session Laws, 1907; the report of the State Board of Health relative to sewage disposal and pollution of public waters, as provided for in Chapter 177, Session Laws, 1907; and the report of the investigation into the cause of spotted fever, as provided for in House Bill 102 of the Tenth Legislative Assembly of Montana.

The work involved in the enforcement of Chapters 110 and 177 is so closely interwoven that the report with regard to one naturally overlaps that with regard to the other, hence no especial differentiation is made between the two reports.

The work under these two laws has been carried forward as rapidly and as thoroughly as possible. The board has been constantly handicapped by lack of funds to employ a chemist when needed and to employ an expert sanitary engineer, as provided for in Chapter 177, but for which no funds were appropriated.

The matter of protecting the waters of our State from pollution is one of vital importance to the people of this State, but this protection cannot be secured and the subject can never be properly studied unless sufficient funds are appropriated for this work.

For instance, the chemical analysis of waters in one proposition alone cost over $300 and in another, a very small one, it cost $100. In these instances chemical examinations only were made, and had bacteriological examinations (which are just as important as chemical if not more so) been made, the cost would have been more than treble this amount.

Chapter 177 is undoubtedly one of the best laws for the protection of inland waters on the statute books of any State in our Union. The enforcement of the provisions of this Act is placed in the hands of the State Board of Health. The Act

does not carry one cent of appropriation, nor was there a special appropriation made, nor was this Act considered when the appropriation was made for the Board of Health. Hence, in passing this law the legislators, undoubtedly unconsciously, placed the Board of Health in the position in which they would place a man to whom they gave a wagon and told him to ride, refusing to give or permit him to secure a horse.

In January, 1908, a meeting of health officers from the various cities and counties of the State was held at Helena. This meeting was largely attended, and had a very essential effect in securing efficient work on the part of the local health officers. Every health officer that attended this meeting expressed himself as more than pleased with the results and every one stated that he had gained much that would be of benefit to his district by attending the meeting. Another meeting of health officers is called for May, 1909. Every health officer in the State should be present at this meeting, and the municipality or county represented by that health officer should pay his expenses, as the information gained at this meeting is not of the least benefit to any physician in his practice, but is of inestimable value to the people whom he serves as health officer.

The health officers of the counties and cities of the State are without exception doing excellent work, and with one or two exceptions the fee received by them as health officer is entirely inadequate and out of proportion to the work required of them.

In several of the small towns of the State, the local health officer serves absolutely without compensation, while in others his salary is merely nominal. Some of the county health officers receive absurdly small salaries, but the majority of the county health officers receive what they ask. In other words, the physicians bid for the position and it is awarded to the lowest bidder. Under this system no health officer can aoffrd to spend the time and money necessary in becoming thoroughly acquainted with the means by which public health is preserved. This is not a part of the regular training of the physician, and requires special study. So long as the health officer holds his position subject to the political vagaries of the locality or is being underbid by other physicians each year he will not and cannot afford to spend the time and money necessary to secure the information required for the most perfect health officer.

All health officers should be appointed at a salary fixed by the appointing power, and he should hold office as long as he faithfully performs his duties. When this is done, the health officers will secure the desired information and will enforce the laws.

Another matter that has been of special interference in the prevention of the spread of disease is the treatment of patients by others than physicians. Physicians are required to, and do report practically all of their communicable diseases, but a large number of people in this State are treated by Christian Scientists, Modern Thought Adherents, and other similar sects, who not only do not recognize contagious diseases at the time they attempt to treat them, but who never report them, whether they recognize them or not.

Several infections in schools have been traced to such cases. Some legal enactment should be made that will require that every person who treats any sick person by any means, material or immaterial, shall report all communicable diseases, and when called upon to treat a case that they do not know is not a communicable disease that they shall call a regularly qualified physician to determine the nature of such disease.

Another matter that has given the health officers of the State some trouble is the action on the part of some physicians who claimed that they did not recognize as contagious diseases cases which they were called upon to treat, and yet when these cases were examined by leading physicians of the locality they pronounced these clearly cases of contagious diseases. Two most flagrant instances of this kind occurred during the last year and there should be some provision made for revoking the licenses or otherwise punishing physicians who cannot recognize cases that are clearly contagious diseases or who refuse to recognize and report such cases when seen by them.

Legislation Recommended by the State Board of Health

In compliance with the provisions of Section 2, Chapter 110, Session Laws, 1907, the following legislation is recommended:

That Section 11 of the above mentioned Act be amended so as to clearly define the term "local health officer." To place the expense incurred in furnishing medical care and attention to the poor afflicted with communicable diseases on the county instead of on the city. To provide that when a city of less than 3,000 inhabitants places itself under the care of a county board of health, such city or town becomes a part of the county, so far as regards the prevention of communicable diseases, and that the health officer of the county shall perform all the duties of health officer within the corporate limits of such town or city without charge to the town or city.

The indication for a clear definition of "local health officer" is self-evident. The placing of the care of the poor, afflicted with contagious diseases upon the city or town, as the present Act does, is unjust because the town or city receives no poor tax.

The object in placing the responsibility of enforcing sanitary measures upon the county health officer in small towns is indicated from the fact that no benefit is derived by the town placing itself under the county board of health if it must pay the county health officer for duties performed within the corporate limits of such town. If the above mentioned provision is not made it would be well to remove the option from the smaller towns of placing themselves under the care of the county board of health, as nothing is gained thereby, unless the county assumes the responsibility.

We recommend that Chapter 25, Session Laws, 1907, be amended so as to require that duplicate copies of all births and death certificates filed in the office of the State Board of Health be filed in the office of the county clerk and recorder of the county in which said births and deaths occurred, instead of their being retained by the local registrars, and that county clerks and recorders be required to file and index such birth and death cer-

tificates in such manner as to enable their prompt and ready inspection by any citizen of this State.

We recommend that an efficient Pure Food law, similar to the Indiana law, be enacted, and that proper officers and the expense involved in the enforcement of such law be provided for.

We recommend that a state chemist and basteriologist be created and a laboratory be provided for him. The present law providing against the pollution of streams with sewage calls for much work by a chemist and one cannot be employed by piece work without a far greater expense than would be involved in securing the entire time of a chemist and basteriologist. Other indications for the need of a state chemist are set forth on page 10.

We recommend that a law be passed providing for the thorough physical examination of all school children in the schools of the State by a physician legally qualified to practice medicine and surgery in Montana, the expense of such examination to be paid for from the school funds of the district.

At a meeting of health officers of the various districts in Montana, held in January, 1908, the following resolution was adopted:

Whereas, For the better protection of the health of the school children of the State, medical inspection of the public, private and parochial schools is urgently demanded; therefore, be it

Resolved, That the State Board of Health use all possible endeavor to cause such additions to be made to the statutes or a law to be enacted adding to the membership of the State Board of Public Instruction the secretary of the State Board of Health.

This resolution was approved by the State Board of Health and the enactment of such a law recommended.

Need of a State Chemist and Bacteriologist.

A chemist and bacteriologist is an essential adjunct to a state board of health. Many conditions cannot be even partially investigated without the services of a chemist and bacteriologist. Certain diseases of a communicable character appear in doubtful forms. In such cases, their character can be determined only by a bacteriological examination, and in the large majority of instances the person suffering from the disease is not able to pay for such examination or is unwilling to do so, and justly unwilling, because the examination is necessary to protect the uninfected from the disease. This is especially true in diphtheria and tuberculosis. In typhoid fever a positive diagnosis is sometimes impossible, but if the doubtful cases were detected by bacteriological examination the excreta would be properly disinfected and many cases of this disease prevented. During the last year the Board of Health has expended for examinations for diphtheria and tuberculosis $360. With this amount spent not more than one-fourth of the examinations desirable were made.

Questions relative to purity of water supplies are constantly coming before the board, and these can be determined only by chemical examinations. Only a small portion of the examinations were made during the last year that should have been, and yet this item required an expenditure of over $600. In addition to this, frequent water analysis were made at the expense of local and county boards of health. Section 2, Chapter 177, Session Laws of 1907, requires the State Board of Health to have all domestic waters of the State examined as to their purity and to determine when the same is polluted. To carry out the provisions of this section alone would more than exhaust the entire appropriation made for board of health work. The cost to the State for the entire time of a chemist and bacteriologist would be less than the cost for water analysis alone under the "per sample" system now necessarily followed.

In order that a pure food law may be of any value whatever a chemist is an absolute necessity. With a State chemist provided and a pure food law similar to that now in force in

Indiana, the meat and milk inspection could be secured at a comparatively small cost, as each local health officer is required to be the local meat and milk inspector, and all analysis, both as to pollution and dilution are made by the State chemist. With such a pure food law enacted, the only additional expense to the state in order to secure thorough meat and milk inspection would be that involved in securing the tuberculin testing of the dairy cattle of the State, a measure which would naturally fall to the veterinarian's office. Without a State chemist, Chapter 177, Session Laws, 1907, and the present "Pure Food" law, or any other pure food law that may be enacted are dead letters.

Water Pollution by Sewage.

The last legislature passed a law prohibiting the pollution of domestic waters with sewage. This law was read at a meeting of the American Medical Association in 1908 and was pronounced one of the best laws in the United States.

The importance of this law is not appreciated by the majority of our people. The old idea that a stream will purify itself in a short distance is still maintained by many people in spite of the work of recent years demonstrating that a stream will not purify itself except in a very great distance as regards pollution with disease germs.

In the older states the cities are now put to an enormous expense in order to establish purification plants for their water supplies. This is necessitated by the pollution of streams with sewage. The various cities have established sewer systems emptying into the streams and they have been continued so long that it would be a very difficult matter to discontinue this pollution. Hence the necessity of going to the extreme expense required in establishing and maintaining water purification plants. Nevertheless, in many of the eastern cities sewage purification plants are being gradually installed and new sewer systems are required to purify the sewage before it is allowed to enter the streams.

Montana is peculiarly situated in this respect. The waters of our State rise in our State, hence they cannot be polluted by another state. Our streams are only slightly polluted at the present time and the passage of this law enables us to protect these streams.

By a reasonable expenditure of money at this time we will avoid the extreme cost of establishing purification plants in the future and at the same time avoid repeated epidemics of typhoid fever that must result if the pollution of our streams is continued or increased.

The main trouble with this law is one that does not apply to the law itself, but to a detail in connection therewith, namely, the providing of money necessary to carry out the requirements

of this law. For instance, the State Board of Health is required to employ sanitary engineers. It is also required to make analysis of the waters of the State, and it is further authorized to establish an experimental station to determine the best method of disposing of the sewage in this State.

All of these things require money for their execution, but the law did not provide any money for this work. If the work is to go on money must be appropriated by the legislature.

Another feature which requires attention is that where a city now has a sewer system emptying into a river or stream and such city is required to discontinue the use of such system, it is necessary that some provision be made whereby that city can increase its bonded indebtedness in order to establish a purification plant. In a city already having reached its limit of bonded indebtedness they cannot establish a purification plant unless some such provision is made.

Recent study by the experts of the world has demonstrated that a stream will purify itself from a chemical standpoint in a comparatively short distance and time; that oxidization goes on more rapidly in a stream such as we have in our State than it does in a slow flowing, sluggish stream; hence a chemical examination would show one of our streams apparently free from sewage pollution in a comparatively short distance, but this purification only removes the danger signal in the stream. This danger signal indicates the presence of sewage, but long after the chemical anlysis fails to show the presence of sewage, a bacteriological examination will show the presence of sewage, and the typhoid fever germs and other germs originating therein.

Various examinations have shown that typhoid fever germs will live in water and ice from three weeks to three months, and experts on this subject state, as a rule, that there is no reason to believe that the typhoid fever germ will die more quickly in running water than it will in stagnant water; hence our streams will carry typhoid fever germs for a great distance, and so long as these germs are present the water constitutes a danger to the health and lives of our people.

At the present time our State has only comparatively few sewer systems emptying into water supplies. These systems are located at the following points:

Glendive, Miles City, Billings, Livingston, Bozeman, Great

Falls, Havre, Kalispell, Anaconda, Butte, Missoula, Lewiston and Dillon.

The sewage from Miles City does not empty directly into the Yellowstone River, but into the old bed of a creek that formerly emptied into the Yellowstone River. During the wet season the sewage is flushed from this bed into the Yellowstone River.

The city of Helena disposes of her sewage on a sewer farm from which the city received, I am informed, $400 per year for the use of the farm.

The work of the board under this law has consisted of investigations relative to the matter of pollution now going on in our State, and the methods of disposing of sewage in a sanitary manner which have given the best results in other states. The immediate actions taken by the board in relation to sewer systems have been directed to those contemplating extensive changes in their sewer plants and those constituting an unsanitary condition.

The city of Bozeman contemplated extending her sewer system extensively. Her old system emptied into a small branch of the East Gallatin River, thence into the East Gallatin. This is a small stream and the present amount of sewage emptying into it would cause an unsanitary condition in this stream, hence said city was ordered to install a purification plant in the form of either a septic tank and filter bed or a sewer farm, this purification plant to be constructed in connection with the new sewer system. It was also ordered that when the new system be completed, the old system now in operation be connected with the new and all sewage pass through the purification plant.

The town of Miles City contemplated extending her sewer system across a neck of land emptying directly into the Yellowstone River. The State Board of Health, believing this action to be contrary to law and a danger to the public health, and also believing that the present outlet of the sewer caused an unsanitary condition, ordered that the present sewer system be not extended to the Yellowstone River and that the town of Miles City proceed, in a reasonable time, to take care of her sewage in a sanitary manner acceptable to the State Board of Health.

The town of Forsyth is now constructing a sewer system which will empty into a natural sand filter bed. It was originally intended that this sewer should empty into the Yellowstone

River, but the State Board of Health having prohibited this under the provisions of Chapter 177, the authorities of Forsyth very willingly agreed to take care of their sewage in a sanitary manner, and found that their new sewer system could be made to empty on to a natural filter bed, which will purify the sewage before it reaches the Yellowstone.

Their plans were submitted to the Board of Health, and after they had been investigated by the health officer they were approved by the board.

Examination of Prickley Pear Creek showed marked evidence of sewage pollution. It was found that the sewer from the Alhambra Hot Springs emptied directly into Prickley Pear Creek, and that the sewer from the Sunnyside Hot Springs resort emptied into a small tributary of this creek. The State Board of Health ordered these two resorts to discontinue putting sewage into the creek and to provide some means of purifying the sewage acceptable to the State Board of Health. This order was served on the managers of the respective institutions on July 23, the order providing that this method of purifying the sewage should be installed within thirty days from the service of the order.

In addition to this, the following letter was sent to the mayor and common council of each incorporated city and town in the State:

Gentlemen—At a meeting of the State Board of Health on July 3, 1908, I was directed to call your attention to the provisions of Chapter 177, Session Laws, 1907, of Montana. Your city attorney has this chapter in his copy of the Session Laws.

In brief, this law provides that no sewage shall be put into any stream in Montana. The provisions of this chapter are intended to provide against the conditions that now exist in older cities, namely, pollution of sources of water supply, which pollution is costing the older cities millions and millions of dollars to provide purification plants for their domestic water supplies.

It has been demonstrated beyond question that the old theory of "Self-Purification of a Stream" is false. While a stream will purify itself from a chemical standpoint, bacteria or disease germs existing in a sewage are not destroyed within their natural lifetime, namely 25 or 30 days. Hence, any sewage that may contain typhoid fever germs for instance, and all sewage is apt to contain typhoid fever germs at any time, constitutes a pollution of water which is dangerous to public health.

The enforcement of the provisions of this law is placed in the hands of the State Board of Health, and as a board we believe that this law is intended to be enforced with due judgment; it was not intended that we should immediately call upon all cities, corporations, etc., placing sewage in streams to immediately discontinue same, and this letter is intended to call your attention to the provisions of this law Act in order that you may prepare for compliance with the provisions of this law when called upon to do so, and that in extending your sewer system you may take into consideration these provisions.

Your attention is called to the fact that this law requires that plans of all proposed extensions of sewer systems, whether this extension be great or small, shall be filed with the State Board of Health and the approval of said board secured before such extension is made. This provision must be immediately complied with in all cases.

This letter is not intended as an insinuation that your city is not complying with the provisions of this Act, but is a general letter, sent to all the cities in the State, and is intended merely to call your attention to the provisions in order that you may prepare to conform with its requirements when called upon to do so, and to notify you that you are now called upon to file with the State Board of Health plans of any extension to your sewer system which you may contemplate.

By order of the State Board of Health.

T. D. TUTTLE, Secretary.

In addition to this order, analysis of waters and sanitary inspections were made so far as it was possible without appropriation, which, of course, was necessarily very limited on account of the fact that this law was not contemplated when the appropriation was made for the expenses of the board.

Report on Water Analysis.

January 30, 1908.

To the Honorable Montana State Board of Health:

Gentlemen:

At the request of your honorable board, I have made a preliminary investigation of the possibility of seepage polution from the pond of the Spring Hill cyanide works at Unionville, into a small spring owned by the Helena Water Works Company, and, having finished this preliminary work, I beg leave to report as follows:

In accordance with your instructions I visited the Spring Hill cyanide plant on January 24, 1908. After carefully examining the existing situation and conferring with Mr. Sizer, I decided to conduct a seepage experiment such as will hereafter appear.

Two hundred pounds of salt were emptied into the tailings flume close to the mill, so as to reach the lower pond in a completely dissolved condition. Before the salt had been emptied into the flume, however, large samples of water were taken from the spring below the dam, which is part of the water used by the Helena Water Works Company. These samples were taken in order to ascertain the normal condition of the spring and of the tailings effluent. No cyanide has up to this time been emptied into the pond. Then, according to my instructions, samples from both pond and spring were taken every few hours, day and night, during the whole time of the experiments.

In order to more readily compare the results, I submit to your honorable board a compilation in the form of curves, showing graphically comparisons of waters during the experiment. As your honorable board will notice by the table, the water which is at present flowing from the tailings pond of the Spring Hill Company, is considerably freer from mineral constituents than that which flows from the spring, the normal amount of chlorine contained in the spring being five parts per million higher than the normal amount in the water flowing from the tailings pond. The total amount of mineral constitutents of the tailings water is also noticeably lower. This has led me to the

inference that the spring is fed mainly from other sources than from the contents of the pond of the Spring Hill Mining Company.

By reference to the table, it will be observed that no seepage of any water in the pond could possibly have occurred during the first twenty-four hours, and that the increase of chlorine due to seepage during the next succeeding twenty-four hours amounted to less than seven parts per million, and the maximum increase of chlorine (from the salt) during the entire time of observation, was only 9.9 parts per million, while the maximum amount of chlorine (as salt) in the pond was 106.5 parts of chlorine per million, or an increase of chlorine in the pond water over its normal condition of 88.75 per million.

It is to be clearly understood that we are, in the above experiment, dealing with a chemical body which under the conditions obtaining, is neither absorbed nor decomposed by the substance through which its solution percolates, and, consequently is found in its original unaltered condition in the seepage.

In this respect, as is well known, potassium cyanide differs widely from common salt, inasmuch as the atmosphere, as well as iron and many other substances found in the soil, have a decidedly destructive or decomposing action upon this body, with the formation of entirely innocuous compounds.

It is probable, for the reason just mentioned that with a dilution of the cyanide, it is proposed to allow to flow into the pond from the Spring Hill plant no cyanide will appear in the seepage water. However, this is by no means definitely established, and in my opinion it will be necessary to conduct further experiments to determine the absolute freedom from cyanide of the seepage from the pond.

I would beg to suggest to your honorable board that an experiment, which in my opinion, would be practically free from danger, could be made in the following manner: Allow the mining company to sluice out one of its tanks now ready for that operation, upon the old Whitlach tailings reservoir, so that I may obtain samples of the effluent from such actual operation, and determine its content of cyanide, and further to observe the spring exactly as has been done with the salt experiment. In this way a conclusive result may be arrived at without danger before cyanide solution is allowed to flow into the lower pond.

Concluding, I beg to say that only practical experiments

under natural conditions will lead to definite and true results in this matter, and can be the only proper guide to correct decisions in the future. Respectfully Submitted,

EMIL STARZ.

ANALYSIS FOR SEEPAGE.

Date.	Hour.	Parts per Million Spring.	Parts per Million Pond Overflow Flume.
Jan. 24......	2:30 P. M.	22.07	17.75
		24.85	17.75
		22.07	15.95
	6:30 P. M.	21.30	106.50
	10:30 P. M.	21.30	85.20
Jan. 25......	2:30 A. M.	21.30	78.00
	6:30 A. M.	21.30	71.10
	10:30 A. M.	21.30	71.10
	2:30 P. M.	21.30	62.20
	6:30 P. M.	24.85	58.60
	10:30 P. M.	28.40	51.50
Jan. 26......	2:30 A. M.	26.61	49.70
	6:30 A. M.	28.40	44.40
	10:30 A. M.	28.40	39.10
	2:30 P. M.	26.61	31.95
	6:30 P. M.	30.17	28.40
	10:30 P. M.	28.40	30.17
Jan. 27......	2:30 A. M.	30.17	26.61
	6:30 A. M.	28.40	24.85
	10:30 A. M.	28.40	21.30
	2:30 P. M.	31.95	17.75
	6:30 P. M.	30.17	
	10:30 P. M.	30.17	
Jan. 28......	2:30 A. M.	28.40	
	6:30 A. M.	26.61	
	10:30 A. M.	30.17	
	2:30 P. M.	26.61	
	6:30 P. M.	26.61	
	10:30 P. M.	24.85	
Jan. 29......	2:30 A. M.	28.40	
	6:30 A. M.	24.85	
	10:30 A. M.	26.61	
	2:30 P. M.	24.85	

Analysis of Mineral Constituents of Spring.

Silica	157.8
Lime	120.3
Magnesia	41.7
Alkalies and Carbonic Acid	92.4
Chlorine	21.3
Total Mineral Constituents	433.5 Parts per Million

Analysis of Mineral Constituents of Pond Over-Flow Flume.

Silica	82.2
Lime	36.9
Magnesia	29.9
Alkalies and Carbonic Acid	198.2
Chlorine	17.5
Total Mineral Constituents	364.7 Parts per Million

Helena, Mont., February 20, 1908.

To the Honorable

Montana State Board of Health.

Gentlemen—

With your authority the undersigned have made a series of tests, with the view of ascertaining the possibility of pollution of the bedrock water system owned by the Helena Water Company, through the wash waters of the Spring Hill Mining Company's cyanide plant, and having finished our investigation and tests, we beg leave to report as follows:

Within the last year the Spring Hill Mining Company has erected at Unionville a plant for the treatment of their ores by the McArthur-Forest cyanide process. The plant comprises the mill for stamping and amalgamating the ores, the tank building with its various percolation tanks and precipitation vats, and a settling reservoir for the slimes and exhausted sands.

Into the reservoir flow also the last washings from the extraction tanks, together with the sluicing water which is used to remove the slimes and sands from the various tanks.

The reservoir is connected with a covered wooden box flume, carrying the settled water from the reservoir four miles down Oro Fino Gulch direct into the storm sewer.

The reservoir is constructed by throwing an earthen wall across a narrow part of the gulch, below the mill and plant. This wall is probably thirty feet in thickness at the bottom, and from eight to ten feet wide at the top. The outer face of this wall is well protected against washing by boulder rip rap work. The only opening in the dam is into the above mentioned box flume.

At the foot of the wall of the reservoir there issues a small spring or streamlet of water. The latter flows on the surface for

a distance of about one hundred yards, to the upper, open intake of the Helena Water Works Company. We are informed by the officials of the Water Company that the water flows from this intake, together with other bedrock drainings, into the Hale Reservoir.

We have shown in our preliminary report that such stable compounds like ordinary salt will, in time, percolate with the water through the bottom of the reservoir into the spring, where they are readily detected.

It then remained to be determined if such a readily decomposable body as potassium cyanide could reach the spring in its unaltered condition. In order to arrive at a definite conclusion in this matter we have taken samples from the spring constantly since the 1st of February, 1908, and have subjected such samples to a searching examination, without in a single case detecting even the smallest trace of cyanide of potassium, which tends to show the instability of this substance in very dilute solution under the prevailing conditions.

As a further proof of the destructibility of the potassium cyanide, we made the following experiment:

After ascertaining that the dam was in good condition and in order to allow the Spring Hill Mining Company to proceed with their cyanide work, we had the overflow from the reservoir closed, deciding to hold the waste waters in the pond until the flume, which was frozen, could be thoroughly repaired.

On February the 1st, 1908, a tank of treated tailings was sluiced into the reservoir.

On February 2nd, 1908, traces of free potassium cyanide and yellow prussiate of potash were detected in the water of the reservoir.

On February 3rd, 1908, however, or forty-eight hours after sluicing the first tank into the reservoir, we were greatly surprised upon testing to find the water accumulated therein to contain not a trace of cyanide of potassium, and only infinitesimal quantities of the harmless yellow prussiate of potash.

This phenomenon we believed to be due to the presence of acid iron slimes and tailings, such as are produced from the Spring Hill ores. That our deduction in this case was correct has been shown by later experiments in our laboratory, and entirely corroborating the above.

Later we found that due to the use of lime and caustic soda

during the treatment of the ores, the sluiced out tailings and slimes were so alkaline as to retard the above described action to such an extent that traces of the harmless yellow prussiate of potash began to appear in the spring after the sixth day. Therefore it was decided to recomemnd to the Spring Hill Mining Company the use of concentrates and pyritic ores in large amounts, on such places, and in such manner as to insure an excess of the cyanide destroying agent in the reservoir.

At our last visit to the plant active steps were being taken by the company to make use of the above mentioned suggestions, and we were assured by the offcials of the company that anything we might suggest to reduce the interference of their waste waters with property and life, would be gladly executed.

. The action of the various products formed during the oxidation of pyritic iron ores is not confined to the destruction of the cyanide of potassium alone, but it also causes the elimination of yellow prussiate of potassium, as a possible factor of pollution, through the formation of an insoluble non-poisonous compound with iron.

Concluding, we beg to say that we have never been able to show the presence of potassium cyanide in the spring. However, minute quantities of the harmless yellow prussiate of potash have appeared, but in no case have reached more than four parts per million parts of water, and we believe that the employment of pyritic iron ores, as previously described, will prevent even this small quantity from percolating into the water of the spring.

We would respectfully suggest to your honorable board that the Spring Hill Mining Company be formally requested to maintain their waste flume in such a manner as to be harmless to life and property, within the territory traversed by such flume.

We would further suggest that the Helena Water Company be requested to care for their first intake, or to so protect same as to preclude the influx of waste water in case of accidental damage done to the flume or the reservoir of the Spring Hill Mining Company.

While we have tried not to inconvenience either of the companies involved, we are obliged to respect the rights and safety of the public.

From the numerous tests we have made with the spring water for the presence of potassium cyanide, and the negative results obtained in every instance, we came to the conclusion that

no cyanide of potassium, as such, percolates through the walls and bottom of the reservoir into the spring, and therefore we consider the operation of the Spring Hill Mining Company's plant, under proper observation of the suggestions above made by us, as safe.

We append herewith tables showing the most important analysis made during our investigation, and also photographs for the purpose of showing the plant, reservoir and flume of the Spring Hill Mining Company in its entirety.

Analysis of the Water of the Reservoir of the Spring Hill Mining Co. in Parts Per Million.

DATE	Time Sample Taken	Potasium Sulpho-Cyanide	Free Potasium Cyanide	Yellow Potasium Prussiate	Chlorine	Total Solids
Jan. 24	1 P. M.	......	0 0 0	0 0 0	17.75	364.7
Feb. 2	4 P. M.	......	Trace	Trace	15.75	......
Feb. 3	5 P. M.	......	0 0 0	*Trace	19.25	......
Feb. 4	9 P. M.	......	0 0 0	*Trace	......	......
Feb. 4	6 P. M.	......	0 0 0	Trace	26.25	......
Feb. 6	6 A. M.	......	*Trace	32.2	30.2	......
Feb. 6	3 P. M.	......	*Trace	50.7	37.3	......
Feb. 7	6 A. M.	......	*Trace	32.2	30.2	......
Feb. 7	5 P. M.	......	*Trace	......	......	......
Feb. 8	4 P. M.	......	*Trace	......	......	......
Feb. 8	6 A. M.	......	*Trace	3.50	21,.3	......

* Showing only by distilling with acid and testing as sulfo-cyanide.

DATE	Time Sample Taken	Loss by Ignition	Fixed Mineral Matter	Free Amonia	Albumencid Amonia	Nitrates	Oxygen Consumed
Jan. 24	1 P. M.	......	......	......	......	......	3.5
Feb. 2	4 P. M.	......	......	......	......	......	......
Feb. 3	5 P. M.	......	......	......	......	......	......
Feb. 4	9 A. M.	......	......	......	......	......	......
Feb. 4	6 P. M.	......	......	......	......	......	......
Feb. 6	6 A. M.	......	......	......	......	......	......
Feb. 6	3 P. M.	......	......	......	......	......	......
Feb. 7	6 A. M.	......	......	......	......	......	......
Feb. 7	5 P. M.	......	......	......	......	......	......
Feb. 8	4 P. M.	......	......	......	......	......	......
Feb. 8	6 A. M.	......	......	......	......	......	......

Analyses of the Water of the Spring Owned by the Helena Water Company, in Parts Per Million.

DATE	Time Sample Tuken	Potosium Sulfo-Cyanide	Free Potassium Cyanide	Yellow Potassium Prussiate	Chlorine	Total Solids
Jan. 24	1 P. M.	0 0 0	0 0 0	0 0 0	21.3	500
Feb. 2	4 P. M.	......	0 0 0	0 0 0	28.0	....
Feb. 3	5 P. M.	......	0 0 0	0 0 0	35.5	....
Feb. 4	9 A. M.	......	0 0 0	0 0 0	....	....
Feb. 4	6 P. M.	......	0 0 0	0 0 0	24.5	....
Feb. 5	6 A. M.	......	0 0 0	0 0 0	21.3	....
Feb. 5	6 P. M.	......	0 0 0	0 0 0	28.4	....
Feb. 6	6 A. M.	......	0 0 0	0 0 0	26.6	....
Feb. 6	6 P. M.	......	0 0 0	0.5	26.6	....
Feb. 7	6 A. M.	......	0 0 0	0.5	26.6	....
Feb. 8	6 A. M.	......	0 0 0	0.5	24.85	607
Feb. 8	6 P. M.	......	0 0 0	0.5	26.6	....
Feb. 11	12 M.	0.3	0 0 0	0.5	24.85	465
Feb. 13	1 P. M.	......	0 0 0	1.5	....	....
Feb. 14	2 P. M.	......	0 0 0	2,.0	46.15	457
Feb. 15	1 P. M.	......	0 0 0	3.0	....	....
Feb. 17	1 P. M.	0.8	0 0 0	4.0	....	....

DATE	Time Sample Taken	Loss by Ignition	Fixed Mineral Matter	Free Ammonia	Albumecid Ammonia	Nitrates	Oxygen Gonsumed
Jan. 24	1 P. M.	123	377	0 0 0	0.055	1.00	3.500
Feb. 2	4 P. M.	......	......	......	......	......	......
Feb. 3	5 P. M.	......	......	......	......	......	......
Feb. 4	9 A. M.	......	......	......	......	......	......
Feb. 4	6 P. M.	......	......	......	......	......	......
Feb. 5	6 A. M.	......	......	......	......	......	......
Feb. 5	6 P. M.	......	......	......	......	......	......
Feb. 6	6 A. M.	......	......	......	......	......	......
Feb. 6	6 P. M.	......	......	......	......	......	......
Feb. 7	6 A. M.	......	......	......	......	......	......
Feb. 8	6 A. M.	240	367	......	......	......	......
Feb. 8	6 P. M.	......	......	......	......	......	4.7
Feb. 11	12 M.	125	340	......	......	......	6.9
Feb. 13	1 P. M.	......	......	......	......	......	......
Feb. 14	2 P. M.	110	347	0.056	0.115	0.5	5.2
Feb. 15	1 P. M	......	......	......	......	......	......
Feb. 17	1 P. M.	......	......	......	......	......	......

Analysis of Water from Upper Intake in Oro Fino Gulch Belonging to Helena Water Company, in Parts Per Million.

DATE	Potassium Sulfo-Cyanide	Free Potassium Cyanide	Yellow Potassium Prussiate	Chlorine	Tota Solids
Feb. 12	0 0 0	0 0 0	0 0 0	12.0	296

DAVE	Loss by Ignition	Fixed Mineral Matter	Free Ammonia	Albumencid Ammonia	Nitrates	Oxygon Consumed
Feb. 12	90	206	......	......	......	......

Sample brought by Mr. Backus.

Analysis of Water From the Hale Reservoir Belonging to the Helena Water Company, in Parts Per Million.

DATE	Free Cyanide	Yellow Potassium Prussiate	Chlorine	Total Solids	Loss by Ignition	Fixed Mineral matter
Feb. 12	0 0 0	0 0 0	10.0	289	95	194

DATE	Free Ammonia	Albumencid Ammonia	Nitrates	Oxygen Consumed
Feb. 12	......	......	......	......

Sample brought by Mr. Backus.

Respectfully submitted,

EMIL STARZ.

A. W. BURWELL.

Analysis of Water From Ice Made in Fort Benton.

	No. I.	No. II.
Odor: cold	None	None
Odor: warm	None	None
Appearance	Clear	Cloudy (sediment)
Total solids	50	35
Loss on ignition	17	15
Fixed mineral matter	33	20
Chlorine	2	2
Nitrites	None	None
Nitrates	Traces	None
Oxygen consumed	0.42	0.52
Free ammonia	0.00175	0.004
Album. ammonia	0.006	0.00925
Copper	None	Yes
Zinc	None	Yes
Iron and Alumnia	Yes	Yes

Helena, Montana, March 7th, 1908.

To the Honorable
State Board of Health.

Gentlemen:

At your request I have made a chemical sanatary analysis and survey of the water supply at Clancy (Jefferson County) and the surrounding country, and having finished my investigation I beg leave to report as follows:

The village of Clancy is situated partly in a rather narrow valley, and partly on the sloping foothills of the adjacent mountains. The Pricky Pear Creek winds its way practically through the middle of the village, running almost parallel with the Great Northern Railroad track, on both sides of which are situated the dwellings of the inhabitants.

Into the Prickly Pear Creek, just about one-half mile above Clancy, empties all of the sewage of the Alhambra Springs, and also the Warm Springs Creek, carrying the waste waters of the Sunnyside Hotel and the mining camps situated at the head of Warm Springs gulch.

Besides these sources of contamination, the Prickly Pear Creek receives those of Clancy itself and the settlements located along the banks, extending many miles above the Alhambra Springs.

Below the village of Clancy, Clancy and Lump Creek empty into the Prickly Pear, carrying the waste waters of the nearby located dwellings and settlements into the latter.

Upon inspection I found that most of the houses are getting their water supply for domestic use from wells, although in some instances the water from the Prickly Pear Creek is used directly or from the Great Northern Railway water tank, into which the creek water is pumped. The lunch room at the railway station at Clancy, for example, uses the water from the railroad tank, which is brought by gravity to the depot.

Along the banks of the Prickly Pear Creek, in Clancy are also located several daily used privies, the contents of which by reason of the peculiar location of the closets, must necessarily seep into the Prickly Pear Creek, and certainly constitute a constant danger of pollution with infectious matter.

In most instances I found the privies in Clancy located above the wells, on more or less sloping hillsides, so that seepage from the privies into the wells is almost sure to occur at any

time. The bottom of most of the wells is about level with the Prickly Pear Creek bed, and it is safe to assume that infiltration from the polluted creek water constantly takes place. The ground through which the water seeps is formed of loose gravel, deriving mostly from decomposed granitic rocks. The filtering quality of this loose gravel is practically nil, as far as bacterial organisms are concerned.

The chemical and sanitary anaylsis of the water from the wells from which samples were taken, with the possible exception of the Goggin, Staph and Hundly wells, showed pronounced pollution, and, mildly expressed, an unsafe condition. The same is also true of the water samples taken from the Prickly Pear Creek at and near Clancy ,including the Great Northern Railway water tank.

The Prickly Pear Creek receives its main pollution from the sewage of the Alhambra Springs and Sunnyside Hotels and bathing establishments, together with contaminating matter of the various privies and barnyards located along its banks, and unless a practical, economical way for the disposal of the sewage is found, the water of the creek will always be dangerous for domestic purposes.

Concluding, I beg to say that some of the wells, as for instance, those of Mrs. Young, Cooper and Streib, are so highly polluted that steps should be taken to have them ordered abolished. I also would humbly suggest to your Honorable Board to notify the School Authorities of Clancy not to allow the school children to drink unboiled water from any of the polluted wells and creeks.

The charts and annalyses herewith affixed will show in detail the condition of each sample of water from the wells, creeks and other sources from which they were taken.

Respectfully submitted.

EMIL STARZ.

(1) ANALYSIS OF SAMPLES.
Mrs. Young's Well.

Chlorine	30.0
Oxygen Consumed	6.6
Nitrogen as Nitrites	Trace
Nitrogen as Nitrates	2.50
Nitrogen as Ammonia by direct Nesslerizing	15.
Total Solids	407.0
Loss by Ignition	170.0
Fixed Mineral Matter	237.0
Phosphates	Strong trace.

Parts per million parts of water.

(2) ANALYSIS OF SAMPLES.
Cooper's Well.

Chlorine	24.0
Oxygen consumed	4.8
Nitrogen as Nitrites	Trace
Nitrogen as Nitrates	6.0
Nitrogen as Ammonia by direct Nesslerizing	11.0
Total Solids	544.0
Loss by Ignition	134.0
Fixed Mineral Matter	410.0
Phosphates	Strong trace.

Parts per million parts of water.

(3) ANALYSIS OF SAMPLES.
Streib Well.

Chlorine	28.0
Oxygen Consumed	4.6
Nitrogen as Nitrites	6 0
Oxygen as Nitrates	3.0
Oxygen as Ammonia by Direct Nesslerizing	Traces
Total Solids	546.0
Loss by Ignition	122.0
Fixed Mineral Matter	424.0
Phosphates	Strong trace.

Parts per million parts of water.

(4) ANALYSIS OF SAMPLES.
Goggin Well.

Chlorine	14.0
Oxygen Consumed	2.6
Nitrogen as Nitrites	Trace
Nitrogen as Nitrates	Faint trace
Nitrogen as Ammonia by Direct Nesslerizing	Trace
Total Solids	304.0
Loss by Ignition	94. 0
Fixed Mineral Matter	210.0
Phosphates	000.0

Parts per million parts of water.

(5) ANALYSIS OF SAMPLES.
Huntley Well on Clancy Creek.

Chlorine	8.0
Oxygen Consumed	11.0
Nitrogen as Nitrites	Traces
Nitrogen as Nitrates	Strong traces
Nitrogen as Ammonia by Direct Nesslerizing	0.0
Total Solids	186.0
Loss by Ignition	68.0
Fixed Mineral Matter	118.0
Phosphates	0.0

Parts per million parts of water.

(6) ANALYIS OF SAMPLES.
H. F. Staph Well.

Chlorine	12.0
Oxygen Consumed	4.4
Nitrogen as Nitrites	Traces
Nitrogen as Nitrates	0.0
Nitrogen as Ammonia by Direct Nesslerizing	0.0
Total Solids	276.0
Loss by Ignition	64.0
Fixed Mineral Matter	212.0
Phosphates	0.0

Parts per million parts of water.

(7) ANALYSIS OF SAMPLES.
Prickly Pear Creek at Head of Wanderer's Ditch.

Chlorine	10.0
Oxygen Consumed	3.0
Nitrogen as Nitrites	0.0
Nitrogen as Nitrates	Traces
Nitrogen as Ammonia by Direct Nesslerizing	5.0
Total Solids	248.0
Loss by Ignition	68.0
Fixed Mineral Matter	180.0
Phosphates	Traces

Parts per million parts of water.

(8) ANALYSIS OF SAMPLES.
Prickly Pear Creek Above Mouth of Clancy Creek.

Chlorine	11.0
Oxygen Consumed	4.7
Nitrogen as Nitrites	Traces
Nitrogen as Nitrates	Strong traces
Nitrogen as Ammonia by Direct Nesslerizing	Traces
Total Solids	216.0
Loss by Ignition	72.0
Fixed Mineral Matter	144.0
Phosphates	000.0

Parts per million parts of water.

(9) ANALYSIS OF SAMPLES.
Great Northern Railway Tank at Clancy.

Chlorine	10.0
Oxygen Consumed	5.0
Nitrogen as Nitrites	0.0
Nitrogen as Nitrates	Strong traces
Nitrogen as Ammonia by Direct Nesslerizing	0.0
Total Solids	216.0
Loss by Ignition	58.0
Fixed Mineral Matter	158.0

Parts per million parts of water.

(10) ANALYSIS OF SAMPLES.
Prickly Pear Creek, Just Below Mouth of Alhambra Sewer.

Chlorine	17.0
Oxygen Consumed	9.1
Nitrogen as Nitrites	0.0
Nitrogen as Nitrates	0.0
Nitrogen as Ammonia by Direct Nesslerizing	15.0
Total Solids	294.0
Loss by Ignition	76.0
Fixed Mineral Matter	218.0

Parts per million parts of water.

(11) ANALYSIS OF SAMPLES.

Prickly Pear Creek, Between Mouth of Alhambra Sewer and Section House.

Chlorine	10.0
Oxygen Consumed	6.4
Nitrogen as Nitrites	0.0
Nitrogen as Nitrates	Strong traces
Nitrogen as Ammonia by Direct Nesslerizing	Traces
Total Solids	224.0
Loss by Ignition	60.0
Fixed Mineral Matter	164.0

Parts per million parts of water.

(12) ANALYSIS OF SAMPLES.

Prickly Pear Creek, Above Section House.

Chlorine	10.0
Oxygen Consumed	8.0
Nitrogen as Niitrites	0.0
Nitrogen as Nitrates	Strong traces
Nitrogen as Ammonia by Direct Nesslerizing	Traces
Total Solids	204.0
Loss by Ignition	60.0
Fixed Mineral Matter	144.0

Parts per million parts of water.

(13) ANALYSIS OF SAMPLES.

Warm Springs Creek, Below Hog Pen Near Sunnyside Hotel.

Chlorine	8.0
Oxygen Consumed	5.4
Nitrogen as Nitrites	0.0
Nitrogen as Nitrates	0.0
Nitrogen as Ammonia by Direct Nesslerizing	0.0
Total Solids	180.0
Loss by Ignition	54.0
Fixed Mineral Matter	126.0

Parts per million parts of water.

(14) ANALYSIS OF SAMPLES.

Warm Springs Creek, Above Hog Pen in Front of Sunnyside Hotel.

Chlorine	6.0
Oxygen Consumed	10.0
Nitrogen as Nitrites	0.0
Nitrogen as Nitrates	Traces
Nitrogen as Ammonia by Direct Nesslerizing	Traces
Total Solids	194.0
Loss by Ignition	80.0
Fixed Mineral Matter	114.0

Analysis of Kalispell Waters.

Altogether I received six samples, as follows:

(1) From Duffy's House, Iron Pipe, July 12, 1908.

(2) From Duffy's House, Wooden Pipe, July 12, 1908.

(3) From Stillwater, July 12, 1908.

(4) Intake Well, July 12, 1908.

(5) Tap in Conrad Block, July 21, 1908.

(6) Court House, July 21, 1908.

The macrosopic examination of the above samples showed in all a more or less floculent, rusty looking deposit. In order to determine the nature of the sediment in each sample of water I centrifugalized it and then examined the concentrated sediment microscopically. I found in every instance tufts or filaments of "Cladothrix Dichotoma," (Cohn) and in some samples associated with it "Crenothrix Kuehniana." These vegetable organisma are classed by some investigators among the algea, while others class these same organisma among the Schizomycetes. At any rate they lay on the border land of both, possessing features of algea as well as of the Schizomycetes. The Cladothrix as well as the Crenothrix have the peculiarity of abstracting and depositing iron from the water. They deposit the iron as hydrated oxide of iron in their sheaths

and cells and therefore they appear as rusty, yellowish brown specks floating in the water.

The generic character of Cladothrix dichotoma is the formation of pseudo branches. Under a sufficiently high power however, the branched appearance is seen not to be a true dichotomus ramification but the result from the growing out in a lateral direction of a detached segment. The filaments of the Cladothrix dichotoma are generally straight, but sometimes they appear in a twisted spiral form.

The Crenothrix appears in its different stages of development as cocci, short rods or long filaments. The cocci form, Zooglea masses, which sometimes accumulate in enormous quantities in water supplies. At first they are colorless but later on they are colored yellowish brown from the deposition of iron oxide within their cells or rather within their gelatinous sheaths. The rod shaped segments which are enclosed in a gelatinous sheath break into sperical bodies which are comparatively large macrococci. The rod shaped and sperical segments escape from the ruptured extremity of the common sheath. Sometimes the sheath becomes permanently gelatinous and the cocci and rods remain then in situ and germinate; in this case they break through the gelatinous wall and the original filament is seen to be surrounded by a brush like outgrowth of small filaments. The filaments are sometimes wavey or even spiral in form.

Both the Cladothrix and Crenothrix are found in running and stagnant water and develop sometimes so abundantly, as in the Kalispell water supply, that the water is made unfit for drinking or certain industrial purposes.

To my knoweldge this is the first time contamination of a water supply with Cladothrix dichotoma (and Crenothrix Kuehniana) was found in this State. The remedy I would suggest is treatment with copper sulphate or with lime or with both. It is said that these organisms, which are fast growing in the dark, (pipes, wells etc.,) cannot live in water containing less than three tenths of one milligramme of soluable iron salt per litre (Frieman and Gaetner).

From the microscopical investigation of all the samples it is evident that the infection with this organism is general in the water supply of Kalispell.

Respectfully submitted,

(Signed) EMIL STARZ.

Analysis of Samples of Water From the Water Supply of Plains, Montana.

Color	Normal.	
Reaction	Neutral.	
Sediment	Very little, mostly earthly matter.	
Total Mineral Solids	5.0	parts
Chlorine	0.4	per
Oxygen Consumed	0.3	one hundred
Free Ammonia	0.008	thousand
Albuminoid Ammonia	0.0045	parts
Nitrites	None	of
Nitrates	Trace	water

Number of Bacterial Colonies received from 1 cc of water equal **78.**
Direct Microscopical Examination: Few Diatoms, few Protozoa, very few filaments of Pscillarici, Detritus.

(Signed) EMIL STARZ.

Inspection of Public Institutions.

Investigation of Sanitary Conditions of Orphans' Home at Twin Bridges.

April 27, 1907.

The investigation of this institution shows a number of unsanitary conditions. The full report of conditions found and recommendations in regard thereto submitted to the Board of Directors of said institution and to the Governor of the State. A copy of this report is on file in this office and can be seen by anyone interested in the subject.

It is not deemed wise to publish this report in full, and the following second investigation of said institution shows that nearly all of the conditions complained of have been remedied.

Orphans' Home at Twin Bridges.

Second Investigation, July 30, 1907.

On this inspection I found that a large majority of the recommendations made in our former report had been complied with. The new cottage had been completed and is in every way a sanitary building.

The plumbing condemned in our former report has been replaced by modern sanitary plumbing. In the main building the floors in the basement are still in bad shape. These floors should be removed and replaced by cement or hardwood floors. As the floors in each of the old buildings become worn they should be replaced by hardwood floors. This is not only a sanitary measure, but is an economical measure, as the little feet running over the soft wood floors wear them out so fast that it would be cheaper to put in the hardwood floors than it would to replace the soft wood floors so frequently. When the soft wood floors are worn out they cannot be kept clean.

Our recommendation with regard to keeping a record of all sick children has been complied with, but I note that a physician has not been regularly employed, and one is rarely called.

I note repeatedly in the record book the diagnosis of ton-

silitis. In one case I note that a child was reported with tonsilitis and shortly after the same child was reported with an abscess of the ear. In a family with a few children it is alright for a mother to make a diagnosis of tonsilitis and treat the child, but with a hundred or a hundred and fifty children in an institution the diagnosis of tonsilitis becomes a very important matter. You will recall that there was an epidemic of scarlet fever, followed by diphtheria during 1906 and 1907. Such an epidemic is liable to result at any time from a mistaken diagnosis between tonsilitis and diphtheria. I still maintain that it is right, and strongly urge that a physician should be employed to treat all children sick at this institution, and the best physician possible should be secured.

Inspection of the School for the Deaf and Blind, Boulder.

November 15, 1908.

The inspection of this institution was made at this time on account of the fact that several cases of diphtheria have been reported from there.

This institution is composed of three buildings, connected by covered passageways. In making this investigation I started with the building devoted to Feeble Minded Children. This is a new building and everything in it is as neat and clean as possible, and in the most sanitary condition. The plumbing is all of strictly sanitary type, and there is absolutely no odor detected in any water closet, not even from the open urinals in the boys' departemnt.

The kitchen is located in the center building, which contains a gymnasium, printing office, and other manual training departments. Each building has its own dining room and table-ware, but all cooking is done in the one kitchen. Everything in this department is kept in a perfectly sanitary condition.

The dormitories are all large and abundant air space provided for the children occupying such. They are well lighted and ventilated. In mentioning approval of this condition to Superintendent Milligan he remarked that he would rather give up his own sleeping room than to see these unfortunate children crowded.

Main Building.

The main building, where are quartered the deaf and blind children, is the oldest building of the institution, and all cases

of diphtheria, eight in number, originated in this building. There was absolutely no evidence of lack of care, and everything was as clean as is possible to be made. However, there are certain conditions in this building that need attention. On the girls' side of the basement, the water-closet contains four stools, of an old fashion and unsanitary type; all being connected to a single water tank, all emptying into one pipe, with no trapping between the stools. This is an unsanitary method of disposing of sewage. On the boys' side new water closets have just been installed, and the old one, of a very unsanitary type, torn out. The room formerly occupied by this water closet gave forth a very foul odor but is being torn up and within two or three days a new cement floor will be laid, the walls replastered and painted, and the room put in a sanitary condition. The wash room has a cement floor that is considerably worn and broken, making it impossible to keep in a sanitary condition. The same is true of practically all the plumbing in the main building, and while I cannot say that it is absolutely necessary that all this plumbing be torn out and replaced with sanitary plumbing, I believe the lives of the children in this institution are not being properly cared for with the plumbing now in use. It is my opinion that the old water closet on the boys' side of the main building was the cause of the present outbreak of diphtheria.

Sewer.

There is a sewer line extending from the main building, in a northerly direction, emptying into the creek. A similar sewer line extended from the new buildings to the creek, but last winter it was found this sewer was not properly constructed (the sewage would back up into the basement of the buildings) so it was tapped about 300 yards from the buildings and an open cesspool constructed. This cesspool constitutes a decidedly unsanitary condition, but as it is located such a distance from the buildings, I doubt if it had anything to do with the outbreak of diphtheria. A new sewer line is now being constructed to take care of the sewage from the new buildings and do away with the above mentioned cesspool. It is expected this line will be completed within ten days.

There is no hospital or detention house in connection with this institution, and when a child is taken sick with disease, such as diphtheria, and it is impossible to at first say whether it is

or is not diphtheria, this child must remain in the instituton until diagnosis is positively made, when it is transferred to a house on the farm, now used by the management for the care of those sick with diphtheria. On the grounds, near the main building, is a small building, known as the "Log Cabin", which can be converted into a comfortable two or three room house at nominal cost, and be used as a detention house, so that children need not be kept in the main building until positive diagnosis is made and other children exposed to the disease.

Diphtheria.

There have been nine cases of diphtheria at the institution this fall, the first case having been taken sick on October 2nd and the last on November 11th. With the exception of the second case I was unable to find any evidence that any child had contracted the disease from another, and the dates at which these cases appeared, namely, October 2. 6, 17, Novmber 1, 3, 4, and 11, would indicate that they did not contract the disease, one from another, unless it be that those on the 3rd and 4th of November contracted it from the child taken sick November 1st, the other cases being so far apart that the period of incubation is exceeded. In addition, two cases occurring on the 3rd, while both in girls, they were not associated either in class room or dormitory, and had the disease extended from one to the other, it is impossible that other children would also have been affected. Every precaution possible has been taken by those in charge to stamp out this disease and this fact is evident, when you consider that out of 125 people associated as closely as they must be in an institution of this kind, only nine cases developed, and one of those being in the nurse caring for the patients.

Rccommendations.

I would respectfully recommend that the plumbing in the old building be entirely replaced with plumbing of a modern and sanitary type; that cement floors be placed in the main corridor of the basement, the wash room and closets of the main building; that the building known as the "Log Cabin" be placed in proper condition and used as a detention house, for cases suspected of having contagious disease, and, naturally we recommend the abolition of the water closet and cesspool mentioned above as being unsanitary. Both of these are being re-

moved and will have been placed in an entirely sanitary condition before this report reaches your honorable body.

I wish to commend the management of the institution for the clean condition in which the institution was found, and for their earnest efforts to stamp out a disease which may have proven fatal to many of these unfortunate children.

To the Board of Trustees at the Montana State School for the Deaf and Blind at Boulder.

At the request of the Superintendent of the School for the Deaf and Blind at Boulder that an opinion be given as to the specific portions of plumbing necessary to be removed in order to place the main building in a sanitary condition, I went to Boulder on February 4th and again examined the plumbing in the old building and found the following conditions:

Girls Side—The closets in the basement are all of a decidedly unsanitary type and should be replaced by modern sanitary closets. In the serving room there is an old sink used for washing dishes, etc. This sink has become rough and it is impossible to get it thoroughly clean, though I wish it distinctly understood that there was no evidence that this sink or any other portion of the building was not kept as clean as possible under existing conditions. This sink should be replaced by an enamel sink which is easily kept clean and sanitary.

On the second floor the stool in the toilet room is between three wash basins and the bath tub, and the connections for the three are so arranged that it is utterly impossible to keep the place clean, and the space is so small that it was necessary to cut a hole in the plaster before the bath tub could be placed. Most of the plumbing in this room is of the old-fashioned lead variety that will spring aleak on the least provocation. I recommend that the three wash basins be removed and replaced by two basins of the modern sanitary type, with exposed plumbing, and that the stool be removed from its position to the side of the sewer pipe toward the door, thus making room for the bath tub to be placed and the break in the plaster repaired.

The teachers' closets are fitted with old-fashioned lead plumbing, with many patches, and evidences of frequent breaks. These should be replaced by modern open plumbing of a sanitary type.

On the third floor, the wash room for the blind girls is fittted with lead plumbing, and regardless of frequent repairs, showed several small leaks on inspection this morning.

Boys' Side—The room from which the old water closet had just been torn out on my last inspection has been repaired and placed in a sanitary condition. The fittings in the new toilet room are of a modern and sanitary type, and cannot be improved on, but the walls of this room have not been properly finished ,and there is an opening in the ceiling about 2 by 10 feet. This condition leaves the room subject to infection, with practically no means of thoroughly disinfecting it when once infected. I strongly recommend that the walls and ceiling of this room be immediately finished and painted.

In the boys' wash room the wash stands are fitted with old-fashioned lead plumbing, as stated in my last report, and the stand itself is broken. The plumbing at this time is leaky and constitutes a constant source of danger. The bath tubs for the boys are located in this room, so that with the room occupied to its fullest extent there would be two boys in the bath tub and ten bathing at stands. While this may be alright from a sanitary standpoint, it doesn't apepal to me from a moral standpoint, for I do not think that it is well for boys to occupy bath tubs with other boys present when this can be avoided.

The floor in the wash room, as stated in my previous report, is badly worn and needs replacing. I therefore recommend that the wash stands be replaced by modern stands with open sanitary plumbing, and that the bath tubes be placed in the adjoining room, which the Superintendent assures me can be devoted to this use without inconvenience.

In the boys' toilet room on the second floor the connections under the wash basins are of the old-fashioned lead type, and are badly worn. The plumbing connections at the stool are so placed that it is impossible to keep the place clean. The cost of changing these connections so that the pipes will be raised a short distance from the floor would be very small, and would change this room from an unsanitary to a sanitary room. The teachers' toilet room on the second floor is in good condition, the only objection here being the lead trap under the wash basin.

On the third floor the boys' wash room has been greatly improved since my last inspection, by the removal of the un-

necessary pipes left there after the plumbing was last repaired. The only change in this room that is necesasry is the removal of the lead pipes under the wash basins, which are worn and leaky. As soon as the repairs are made in any of the rooms mentioned the walls and all woodwork should be immediately painted.

When to Make These Changes.

At the time of my last inspection diphtheria prevailed in the school. I stated it was my belief that the disease was entirely due to the unsanitary conditions in the room from which the water closets had been removed on the boys' side. Almost immediately after this room was repaired, cleaned and placed in a sanitary condition the disease stopped, which would seem to support my opinion in the matter. However, lest the question be raised as to whether diphtheria will result directly from sewer gas, I wish it distinctly understood that it is not my belief that the diphtheria resulted from the sewer gas, but that the sewer gas and other poisonous vapors originating from this old room so depleted the vitality of the children that they were placed in a condition to be overcome by any disease germs that they might come in contact with. There being no disease prevalent at the school at this time, and it being my firm belief that when the water closets in the basement on the girls' side are torn out the conditions will be similar to those in the boys' room, mentioned above, it is doubtful whether or not it is best to change this plumbing while the school is in session. The changing of the plumbing in the boys' wash room would probably not result in producing similar conditions, but tearing up the floor might do so. We are thus placed in a position where we must choose between taking chances from infection due to improperly constructed water closets or from the result of tearing out these improperly constructed closets.

It is my opinion that the least danger lies in keeping the place as clean as it is possible for it to be kept until the close of the school, and that then the changes recommended may be made during vacation. However, I strongly recommend that the new toilet room on the boys' side be placed in a sanitary condition by giving the walls and ceiling a smooth finish and painting these, together with all wood work in the room. This measure is essential in order that should any disease break out in the school this room might be protected.

Inspection of Reform School At Miles City.

This institution has been inspected twice during the two years covered by this report. The institution was found to be in a thoroughly sanitary condition, and every effort is made to protect the health and lives of the inmates. Each child committed to this institution is thoroughly examined by a physician on admission and all clothing brought with such child is disinfected. In addition to this, the child is given separate sleeping quarters for a period of two weeks in order that any contagious disease to which he or she has been exposed shall have time to develop and thus avoid exposing the other children. A physician is constantly employed to look after the sick children in the institution.

The only condition in this institution to which we desire to call attention is the sewer system, which empties indirectly into the Yellowstone River. This sewage could be very well used for irrigation.

At the side of the building there is a well leading down to the sewer, which forms a kind of a trap in the sewer. This well must be repeatedly cleaned out, and I am unable to see what benefit is derived from it. It is not a flush tank in any sense of the word and I have never seen nor heard of such a trap being placed in any sewer system except in this one instance. I consider it an unsanitary condition that should be abolished.

Plans for Public Buildings Inspected.

Bozeman—George Cox Theatre Building.

This is a one-story and basement building, the basement being used as a bowling alley and the first floor as a theatre. The building is designed to seat three hundred people. The auditorium has a capacity for 3,280,00 cubic feet of air, which is changed by 57 square feet inlet ventilating capacity and 80 square feet of ventilating flues in the ceiling, thus furnishing capacity for perfect ventilation. It is estimated that the building can be emptied in case of fire within two minutes, there being four exits, with two additional exits back of the stage.

This plan was approved.

Glasgow—Public Library.

This building is intended for use as a public library. The ventilation is secured by the usual ventilators in the walls, connecting with a single ventilating flue. The heating system is of the hot air variety and is a most sanitary heating plant, provided the cold air flue is always kept open. Water closets are being installed in this building, although there is no sewer system at present in Glasgow, and the water closets cannot be used until a sewer system is installed. The plans do not show a ventilation opening in the basement, where two club rooms are provided. This defect was brought to the attention of the committee in charge of the building. The air current in the ventilating shaft is induced by heating the shaft from the furnace chimney, the two chimneys being adjacent.

This plan was approved, provided, a ventilator be installed in the basement.

Missoula—High School Building.

In this building the heating system is known as the blast system. Fresh air will be taken from the outside at the roof of the boiler house, drawn over heating coils into blower and thence into galvanized iron duct system to a system of brick flues. This air will be blasted into the various rooms through register screens, located about eight feet above the floor line,

threby forming a pressure on the rooms, causing the foul air to be forced out through register screens at the floor line into vent stacks, which will discharge into attic space, and from the attic space the foul air will be disharged into atmosphere through a roof ventilator. In addition to this direct radiation coils are placed in certain rooms.

The contractor is required to guarantee that the blower will deliver 24,900 cubic feet of air per minute when revolving at a speed of not exceeding 226 revolutions per minute. He shall further guarantee that the blast system, as above specified, will heat each of the rooms into which the blast is introduced to 70 degrees with a minimum outside temperature of 25 degrees below zero.

The lighting of the school rooms is well above the light required (that the square feet of glass in the windows shall equal one-sixth of the floor space). All light is admitted from two sides of the room.

Toilet rooms, with individual stools of a sanitary type, are provided on the first floor, each stool having a separate ventilating pipe. There is no sewer system now adjacent to this building, but the building is being constructed so as to connect with the sewer system when installed.

The plans of this building were approved.

Helena—Central Heating Plant and Gymnasium.

This building is constructed to furnish gymnasium room and manual training room and a central heating plant for the school buildings adjacent thereto in Helena. In the basement room is located the heating plant. On the first floor is located the manual training room, engineer's room, and toilet room. The ventilation of the manual training room is secured by ventilators connecting with the ventilating shaft, the current of air in this shaft being induced by steam coils placed at the bottom. Ventilation for the toilet room is secured by ventilators opening back of the stools, passing under the floor and connecting with an individual ventilating shaft. The current of air in this shaft is induced by steam coils at the bottom of the shaft. The size of the flue and ventilation openings into the rooms, in both the toilet and manual training rooms, is such as to change the air five times per hour, with the air moving at the rate of 200 feet per minute, which is very easily accomplished with a ventilating system of this kind. The toilet rooms

are provided with individual stools of a modern sanitary character.

The gymnasium room is ventilated only by windows, and in approving this building we urged that a rule be strictly enforced requiring that a window in each of the gable ends of the building be kept open at all times when pupils are exercising in this room, and that when a contest is being carried on or a large number of pupils are exercising in the gymnasium, all of the windows in each of the gable ends be kept open.

With this suggestion the plans were approved.

Helena—Parochial School.

This is a very large school buliding and is built on the most modern sanitary plans. The heating is by steam plants and ventilation is secured through a central forced-air ventilating shaft. The toilet rooms are provided with the most modern sanitary devices and are located on each floor. The modern system, known as the drinking fountain is being installed in this building. This is the first building of which we have received plans in which this modern means of preventing the spread of diseases is being installed. It is the system that should be installed in every school building in our State, where running water is provided.

The area of glass in the windows of the rooms of this building is equivalent to a little more than one-third of the floor space.

This building is heartily approved.

Kalispell—Annex to West Side School Building.

The heating plant of this building is of the blast variety and is similar in every respect to that described in the Missoula High School above. The toilet rooms, located in the basement, are provided with cement floors, the stools are individual and separately trapped, and in every way sanitary. The lighting is well within the requirements of the Montana regulations.

The plans of this building, received three days after that of the parochial school, provide for a sanitary drinking fountain, and were approved without question.

Havre—School Building.

A steam heating plant is contemplated in this building. Ventilation is secured by a central ventilating shaft with star ventilators. The proposed plan shows a ventilating system in

which it would require that the air pass through a ventilator at the rate of 600 feet per minute in order to change the air of each room five times per hour. It is improbable that a ventilating system of this kind would cause the air to travel at this rate. The lighting is well within the requirements for Montana. The building is provided with water closets in which the old single trap system is proposed, and the urinals on the boys' side are not provided with flush tanks.

These plans were approved with the following condition:

That the contractor or architect be required to guarantee that the ventilating system will change the air in each room not less than five times per hour; that the heating plant will maintain a temperature of 70 degrees when the outside temperature is 25 degrees below zero; and that the toilet rooms be provided with stools having individual, automatic flush tanks, and automatic flush tanks also for the boys' urinals.

On July 15th we received corrected specifications from the architect, increasing the ventilating capacity, providing for modern sanitary toilets and urinals, and calling for a guarantee with regard to the heating and ventilating plants. The plans were then approved.

Communicable Diseases Reported.

Smallpox.

During the last year 717 cases of smallpox were reported to the State Board of Health; during the previous year 164 cases were reported, with 129 cases for 1906 and 222 cases for 1905. This shows a gradual increase in the number of cases reported during the last four years, though 1905 shows more cases than 1906 or 1907, on account of the epidemic at Billings, which resulted in 158 cases. The disease appeared in epidemic form in Choteau, Flathead, Gallatin, and Missoula counties, while cases were reported from every county in the State, with the exception of Madison and Sweet Grass counties. In regard to Madison county, several of the cases reported from Jefferson county (from Whitehall) originated in Madison county. The disease occurred in epidemnc form in three counties during the warm weather, an unusual circumstance and one that indicated the strenuous measures that would be necessary to prevent a severe general epidemic during the winter. Accordingly the State Board of Health, believing that the circumstances indicated that "Smallpox is threatened" in all parts of the State, issued an order, under the provisions of Section 31, Chapter 110, Session Laws of 1907, that all persons frequenting any school in the State be required to present a certificate of successful vaccination. This order is being complied with in some portions of the State while in other portions it is being disregarded. It is the intention of the Board to wait a reasonable time for those who have thus far neglected to comply with this order, and if they persist in their refusal and neglect, to file complaints and test the legality of their action. It is the positive opinion of the Board of Health that vaccination and vaccination alone will prevent smallpox, that quarantine measures are only palliative measures and that were it not for the children of the ignorant it would be a wise measure to remove smallpox from the list of quarantinable diseases and

depend altogether on vaccination as the sole preventive measure.

The disease on the whole has assumed a mild form, but the report from Flathead county shows that five cases there assumed a most maligant form, while the cases at Bozeman, at first so mild as to be almost unrecognizable, assumed such a form that death resulted. This has been the case in every epidemic we have had. The disease first appears in such a mild form that it is almost without exception designated as chicken-pox, then a few cases of a more severe form appear and are designated as mild smallpox, and if these are not promptly quarantined and a general vaccination of the community performed the most severe form of confluent smallpox develops.

The influence of vaccination in preventing smallpox is well shown from the report of the Bozeman health officer, who states that of the cases reported only two were ever vaccinated and that both of these had the disease in a very mild form. While the general reports from over the State show that slightly more than two per cent of the cases have been vaccinated, they also show that not a single case had been vaccinated within six years of the date of exposure if we exclude five cases reported from one county who were vaccinated three days before the onset of the disease. It is a well known fact that smallpox does not appear until from twelve days to two weeks after exposure, and vaccination three days after exposure is not considered a preventive measure, hence these cases cannot be classed as havnig been vaccinated, for they were never vaccinated until at least nine days after exposure, and in using nine days as the time after exposure we are granting that the disease showed symptoms promptly on the twelfth day.

Diphtheria.

Diphtheria has prevailed throughout the State in enidemic form. In no place has it reached epidemic proportions. Cases were reported as follows:

1905	509
1906	351
1907	1116
1908	984

During 1908 there were 984 cases reported with 149 deaths or a mortality of 15 per cent.

In the majority of instances, the date of the disease on which antitoxin was given is not reported, but out of 112 cases in which the day of the disease on which this remedy was given is reported, not a single case died in which it was given before the third day of the disease, while five cases died in which it was given on or after the fifth day of the disease.

This shows the importance of a prompt diagnosis and early administration of antitoxin. In many instances the diagnosis can be made promptly only by a bacteriological examination, and very few physicians are equipped to make this test, hence one of the urgent needs for a State Bacteriologist. The death rate from this disease is higher than it ought to be, and this is, in a large measure at least, because anitoxin is not promptly administered. In some instances, if not in the majority of those in which its administration is delayed, it is because of the fact that the parents cannot afford to pay for the material. Anitoxin is an expensive remedy, and yet, in proportion to its remedial powers, it is one of the least expensive drugs known. Never the less, many a man feels that he cannot afford to pay the five or ten dollars cost unless it is as a last resort, hence many children die because of late administration. Again, antitoxin, given in small doses, is a preventive measure, and every person exposed to diphtheria should be given a preventive dose of anti-toxin. It would well pay the authorities of every county to provide free antitoxin for at least the poor in the county. A moderately well-to-do man can hardly afford to pay for the administration of this preventive measure in a large family and many States and most of the large cities are now providing antitoxin absolutely free to all the citizens, regardless of financial standing, and they have found this to be a very good investment, as it has prevented epidemics and greatly reduced the number of cases that appear in endemic form.

Diphtheria often appears in a very mild form, and is not detected by the physician unless a microscopic examination is resorted to. The very careful physician would make cultures from every sore throat that came under his observation when there was diphtheria in the community, if free bacteriological examination were constantly provided. Again, cases of diphtheria in a mild form are treated at home and by others than physicians, and the same remarks apply here as under scarlatina.

Scarlatina.

Scarlet fever has not assumed epidemic form in any part of the State during the two years included in this report, but it has continued in andemic form during the entire period. We find that cases were reported as follows:

1905	203
1906	207
1907	328
1908	1164

This shows an increase of 836 cases during 1908 over either of the three previous years.

This disease is given comparatively slight consideration, it commonly being supposed to be a very harmless disease in this State. However, the mortality records do not support this idea. We very frequently hear people say that scarlet fever is nothing to be afraid of in this locality, and yet we find that during the year ending November 30, 1908, 80 deaths were caused by scarlatina. We find that 1164 cases were reported, hence the mortality was 6 per cent of all cases reported. It may be claimed that not all of the cases were reported, and it is probably true that they were not all reported, for had they been there would not have been as many cases to report, for it is through the cases that are not reported that the others are contracted. People seem to think that they are doing something smart when they conceal a case of contagious disease, that is in a mild form, and yet the severe cases are contracted from the mild ones and as a result deaths occurred in this State during the last year from this one disease. Some of these cases were honestly never suspected, as it is a disease that does occur in such mild form that it is not infreqnently overlooked by the most careful physician. Such cases cannot be prevented, and failure to detect and isolate them cannot be counted as an error or blamed on anyone. But there are a large number of cases that are sufficiently severe to cause very decided suspicion. In some of these cases the child is not very ill, and a doctor is not called. If the child were not very ill with some disease that did not appear to be suspicious a physician would be promptly called, but there are people who treat this disease and do not call a physician because they do not want to be put to the inconvenience of being quarantined. These people have causd the death of many of those who died from scarlet fever during the last year, and not

only this, many of their own children now have kidney disease and running ears because they were neglected when suffering from a mild form of scarlet fever.

Another cause for the spread of this disease is the fact that many cases are treated by adherents of the "New Thought," "Mental Science" and "Christian Science" faith. Without regard to the value or wothlessness of these methods of treating diseases we believe that some very positive measures should be taken whereby contagious diseases, or those infected with such diseases, may not be allowed to go at large and infect others simply because they are not under the care of a legally qualified physician. It isn't fair to those who employ a physician who has complied with the laws of this State to place them under quarantine while those who employ some one who is not subject to the laws of this State and who are suffering from contagious diseases are allowed to go at large and infect others. Aside from the matter of protecting the public health it is not just to require one who admits that he is a physician to report contagious and infectious diseases, and let those who do not profess to be physicians, but who, nevertheless, attempt to treat diseases, fail to report these cases, or to avoid the provisions of the law by saying that they had no reason to suspect that it was a contagious disease. Every person who treats or attempts to treat diseases by material or immaterial means should be required to know the symptoms of the contagious and infectious diseases.

Is it a harmless disease that causes 80 deaths in one year in this State? Most of them "were only children." The suppression of this disease is largely a matter of educating the people and this the State Board of Health is trying to do by every means at its command, but in the meantime, those who practice medicine, using immaterial measures, should be required to report the cases they are attending.

Typhoid Fever.

During the two years ebraced in this report 1,514 cases of typhoid fever were reported to the State Board of Health. This probably represents a fair percentage of the cases of this disease that occurred in the State and yet we know that a good many cases of typhoid fever have not been reported. Some of these we have been able to detect by the death reports, the person being reported as having died of typhoid fever, and we find-

ing that the case was never reported. We know that there are cases that do not die that are also not reported.

Typhoid fever is known to be a preventable disease. Its source is a matetr of filth. No case of typhoid fever results except from another case of typhoid fever, and the means by which the disease is transmitted from one person to another is the result of filthy practices. For instance, the nurse in charge of typhoid fever patients fails to observe the simple precaution of disinfecting her hands, and as a result, transmits the poison to her system through her food. Again, this nurse fails to disinfect the stools and excrement from the patient, and this is thrown into the sewer, the closet or upon the ground.

All of the excrement from a typhoid fever patient contains millions of typhoid fever germs which live for a long time in nature, and find their way into the systems of people and cause typhoid fever. The stool and urine from a typhoid fever patient is thrown into the sewer before it is disinfected, and from this sewer it finds its way into streams and the sources of public water supply of our State, thus infecting hundreds of people. Or the stool is thrown into a closet, and from the closet seepage extends to our wells and cisters and this seepage carries with it the germs which have been thrown into the closet. Or the stool is thrown upon the ground and from here is carried partly by seepage into the water supplies, partly by surface drainage and, to a far greater extent than is appreciated, by flies.

Flies walk and live in this filth, get their bodies and legs covered with the germ-bearing matter, and from there they go to the baby's bottle or to the dining table, and walk over the food provided for the family.

Typhoid fever would be eradicated from the world if all human excreta were properly taken care of. It is not sufficient to disinfect the excreta of a typhoid fever patient while he is sick only, but this disinfection must be continued for months afterward, for it is a well known fact that the excreta of one who has recovered from typhoid contains germs for months after recovery.

Another prolific source of typhoid fever in this State is the unsanitary condition of the railroad construction camps that have been in operation during the last two years. In many of these camps little or no provision is made for the disposal of human excrement, and as a result, typhoid fever has run rampant

in the majority of these camps.

However, one camp, the physician of which realized the importance of sanitary conditions, and in which some 18,000 men were employed during 1907, did not have a single case of typhoid fever develop. The physician in charge demanded that proper means for the disposal of human excreta be provided, and that the men be required to make use of the places thus provided. As a result of this demand on the part of the physician in charge, the men were protected from the disease, the contractor was able to keep his men and had less dickering with them than had the contractors in camps where typhoid fever and other diseases prevailed, and the physician made a good thing out of his medical contract.

Typhoid fever can be prevented simply by enforcing absolutely clean measures in the matter of the disposal of human excreta and that it is well worth the efforts required to secure this proper disposal of excreta is shown by the cost of typhoid fever to the people of this State during the last two years.

An average case of typhoid fever costs $278. This cost is divided as follows:

The doctor's fee is estimated at $70. I have talked with a large number of physicians of the State with regard to this estimate, and they almost invariably told me that the estimate was too low; that the physician's fee in the average case of typhoid fever is more than $70.

The next item is the nurse hire. If a professional nurse is employed, she receives $25 per week and is required to nurse four weks in the average case of typhoid fever, thus making the nurse hire $100. This may be said to be an unjust charge, because many cases do not have a nurse, but where no nurse is employed, the physician must make more frequent visits and the people of the house must nurse the patient, hence the cost of the nurse must be paid in one way or another. The member of the family who nurses the patient is entitled to compensation, and while such member might not be able to earn $25 a week, her services are of some value and if she is not capable of earning $25 a week, then the patient suffers as a result of improper nursing, and the doctor's bill is increased by the causing of more frequent visits.

From our reports we find that nearly all the cases of typhoid occur among men, and over 85 per cent of them are among men

between 20 and 50 years of age, or during the period of their greatest earning capacity. Typhoid fever incapcitates a man for work for an average of six weeks. We estimate that a man between 20 and 50 years of age in Montana is capable of earning $3 a day. We take it for granted that he will not work on Sunday, therefore he incurs a loss of 36 days of work, or $108, making a total cost of $278, as stated above.

We cannot allow anything for what he would have spent from this $108, for personal maintenance, as the nurse must be boarded and the sick man must be fed during the period of his illness.

If this estimate of the cost of a case of typhoid fever is above the cost in some cases, it is much below it in others, and it must be remembered that not all cases of typhoid fever that have occurred during the last two years in this State were reported.

We do know that during this period there were 1,514 cases of typhoid fever, because this number was reported to the various health officers of the State, and their reports are on file in this office.

With 1,514 cases at a cost of $278 per case, this disease has cost the people of this State $420,892 during the two years ending November 30, 1908.

If this amount of money had been expended in building proper closets and providing means of disinfecting all human excreta in this State and in generally improving the sanitary conditions throughout the State, there could be no source of infection for typhoid fever. Or, if one-tenth of this amount were expended in improving conditions, typhoid fever would be practically unknown in the State, and not only this, but other communicable diseases would be greatly reduced in numbers. In addition to this, the death rate from typhoid fever, which in 1908 was 123, would be none. In other words, if the people of this State can be induced to spend a small per cent of the money they spend in treating typhoid fever, in cleaning up and providing means for the prevention of this disease, 128 lives a year would be saved to this comonwealth, to say nothing of the far greater amount expended in treating this one diseases.

Measles.

There were, as shown by the following table, 1,711 cases of measles reported during the two years ending November 30,

1908, but we fully realize that this represents a comparatively small proportion of the number of cases of measles that occurred in Montana during this time.

Many cases of measles are treated by the head of the house, no physician is called, and the cases are not reported. If inquiries are made regarding the knowledge of the head of the house as to the nature of the disease, it is practically invariably claimed that no suspicion was had as to the nature of the affliction. As the result of this, children attend school not only when they are just getting over measles, but actually suffering from the disease, and all of a sudden an epidemic will spring up and we have a large number of cases reported from a single district.

Measles caused 17 deaths during the last year, but this does not represent anything like the evil effects of this disease, because it so frequently results in diseased ears and eyes, and the child is handicapped for life because parents thought to save a small doctor's bill or to avoid the inconvenience of quarantine.

The teachers in our schools should give more attention to the physical condition of the children under their care. If a child is sick it is in no shape to be in school and should be sent home. If the teacher has any reason whatever to suspect that the child is infected with a contagious disease she should not permit that child to enter school without a certificate from a legally qualified physician, stating that the child is quite free from any disease that may be contagious. This is not done in the majority of cases because the teacher fears to make an enemy of the parent of the child, but she should realize the injustice she is doing the other children under her care.

Report of the

Secretary of the State Board of Health

As State Registrar of Births and Deaths

The law providing for the registration of births and deaths went into practical effect in June, 1907. At this time the various local registrars were appointed and supplied with the necessary blank forms, etc. The rules and regulations adopted and promulgated for the enforcement of this law are among the rules and regulations of the State Board of Health.

In the following tables the principle information obtained from the records secured as a result of this law is set forth. The records for the first six months during which the law was in force are not included, as during this time the physicians and undertakers of the State had not become acquainted with the provisions of the law and the returns are not complete for that period.

Table I. shows all the deaths that have been reported for the year ending November 30, 1908, arranged according to causes as classified by the international classification of causes of deaths and also shows the age at which death occurred.

Table II. shows all deaths as they occurred in counties and cities of over 5,000 inhabitants. Still births are not included in this table. The totals of all deaths by counties and cities is shown on the November sheet of Table II.

Table III. represents the number of births that have been reported, arranged according to the counties in which the birth occurred. It also shows the nationality and birthplace of the parents.

There were 4,353 deaths reported and 5,842 births reported, showing an excess of 511 births over deaths. The births are 3,015 males and 2,827 females.

A study of the following tables will give some very interesting information. For instance, we find that there were 575 deaths from communicable diseases, distributed as follows: Smallpox, 1; diphtheria, 49; scarlatina, 80; measles, 17; whooping cough, 13; tuberculosis, 315, and spotted fever (tick), 6. There were 185 deaths from acute intestinal diseases. Practically every one of these deaths were the result of impure food, principally "doctored" and impure milk, or milk from diseased cows. In addition to this there were 274 deaths from inanition, the

large majority of which were the result of impure food and improper feeding.

Violence caused more deaths than any other cause. Of these, those due to railroad accidents easily lead. The death rate from this cause was increased during the last year by the large number of men employed in railway construction work in the State.

Pneumonia, with 453 deaths to its credit, is the principle cause of deaths among the diseases. It is highly probable that some of these deaths classed as pneumonia were in reality due to tuberculosis. This is due to the antipathy on the part of many people to have a death in the family from tuberculosis go on record.

Tuberculosis caused 315 deaths. This represents 7.6 per cent of all the deaths (excluding stillbirths) that occurred during the year and does not include the enterites and inanitions, many of which were cases of tuberculosis of the bowels. This disease is now recognized as a communicable and preventable disease. In nearly every state in the union, in fact in every civilized country in the world, a determined fight is being waged against this dread disease. In our state little attention is being paid to it. There seems to be an impression that there is practically no tuberculosis in our State, and yet the death records filed in this office show that 7.6 per cent of all the deaths in the State during the last year were caused by tuberculosis. These death records are a matter of public record and can be inspected at any time by any person who wishes to verify these figures. The last legislature struck tuberculosis from its list of communicable diseases submitted by the State Board of Health. Through the educational work of the International Congress on the Study of the Prevention of Tuberculosis, held at Washington this fall, the people of our State are waking up to the importance of fighting this disease and we hope our next report will show that Montana has taken a lead in this work. When the people of this State become interested in a subject and when they see a practical method of fighting a disease they are ready to fight and fight hard. We have good reason to believe that our next report will chronicle a tuberculosis sanitorium in this State, where any person, rich or poor, can be taken care of and where they may not only be cured but learn how to avoid contracting the disease again or giving it to others. This will be

built and endowed by popular subscription.

The chief trouble confronted in enforcing this registration law is found in the difficulty in securing competent persons to act as local registrars, especially in isolated districts. In towns with health officers the health officer must act, but it is necessary to have registrars in districts where only a few births and deaths occur in the course of a year. It is very difficult to secure a competent person to act as registrar for the small fee allowed for this work, where there are only a few cases to record. One might think that any business man would be willing to act in this capacity on account of the convenience afforded the community in case a death occurs, but we have not found it so. We believe it would be a wise move to require justices of the peace to act as registrars of their districts when called upon to do so.

TABLE I.

SHOWING DEATHS BY AGE AND SEX ARRANGED ACCORDING

Sex	M	F	M	F	M	F	M	F	M	F	M
	Under										
Age	1	1	1	2	2	3	3	4	4	5	5
I.											
GENERAL DISEASES.											
Typhoid Fever	...	...	...	1	...	1	...	2	...	2	4
Smallpox	...	...	...	...	...	...	...	...	...	...	...
Measles	3	...	...	2	...	1	1	...	2	...	1
Scarlatina	3	1	2	4	6	6	2	6	9	3	9
Whooping Cough	4	4	...	1	3	...	...	...	...	...	1
Diphtheria	3	4	9	6	6	5	6	4	7	6	17
Grippe (Influenza)	...	1	1	...	1	...	...	...	...	...	...
Spotted (Tick) Fever	...	...	...	...	...	...	...	...	...	...	...
Erysipelas	4	9	...	...	...	...	...	...	...	...	1
Purulent Infection and Septicaemia	...	1	...	...	...	...	1	...	...	...	...
Tubercle of Lungs	2	2	1	...	1	...	...	...	...	...	...
Tubercle of Meninges	...	5	...	1	1	...	...	1	...	...	...
Tubercle of Peritoneum	...	1	...	...	...	...	...	...	...	1	...
Other Tuberculoses	1	...	...	...	...	...	1	...	...	...	1
Syphilis	1	...	...	...	...	...	...	...	...	...	...
Cancer of Stomach and Liver	...	...	...	...	...	...	...	...	...	...	...
Cancer of Peritoneum and Intestines	...	...	...	...	...	...	...	...	...	...	...
Cancer of Female Genital Organs	...	...	...	...	...	...	...	...	...	...	...
Cancer of Skin	...	...	...	...	1	...	...	...	...	...	1
Cancer of Organs not Specified	...	...	...	...	...	...	...	...	...	...	...
Rheumatism, Acute Articular	...	...	...	...	...	...	...	...	1	...	1
Rheumatism, Chronic and Gout	...	...	...	...	...	...	...	...	...	...	...
Diabetes	...	...	...	...	...	...	...	...	...	...	1
Anaemia and Chlorosis	...	...	1	1	2	...	...	1	...	...	...
Alcoholism, Acute and Chronic	...	...	...	...	...	...	...	...	...	...	...
Saturism (Lead Poisoning)	...	...	...	...	...	...	...	...	...	...	...
Other Chronic Poisonings	...	...	...	...	...	...	...	...	...	...	...
Goitre	...	...	...	...	...	...	...	...	...	...	...
II.											
DISEASES OF NERVOUS SYSTEM AND ORGANS OF SPECIAL SENSE.											
Encephalitis	1	1	...	1	...	...	...	...	...	...	...
Meningitis, Simple	1	...	1	1	...	1	...	...	...	...	...
Meningitis, Cerebro Spinal	2	10	12	3	4	3	2	5	3	3	7
Cerebral Congestion and Hemorrhage	...	...	...	...	...	...	...	...	...	...	...
Cerebral Softening	...	...	...	...	...	...	...	...	...	...	...
Paralysis, General	...	...	...	...	...	...	...	...	...	...	...
Other Forms of Mental Alenation	...	...	...	...	...	...	...	...	...	...	...
Epilepsy	...	...	...	...	...	...	...	...	...	...	1
Convlusions of Children	14	9	1	...	...	1	...	1	2	...	...
Tetanus	...	...	...	...	...	...	...	...	...	...	...
Chorea	...	...	...	...	...	...	...	...	...	...	...
Other Diseases of Nervous System	...	1	...	...	...	...	...	...	...	2	...
Diseases of Eye and Adenexa	...	...	...	...	...	...	...	...	...	...	...
Diseases of Ear	...	...	1	...	1	...	...	1	...	...	1
III.											
DISEASES OF CIRCULATORY SYSTEM.											
Pericarditis	...	...	...	...	...	...	...	...	...	...	...
Endocarditis	5	...	...	1	...	...	1	...	...	1	7
Other Diseases of Heart	...	...	...	...	...	...	...	...	...	...	1
Diseases of Arteries (Atheroma, Aneurism)	...	...	...	...	...	...	...	...	...	...	...
Angina Pectoris	...	...	...	...	...	...	...	...	...	...	...
Embolism and Thrombosis	...	...	...	...	...	...	...	...	...	...	...
Diseases of Lymphatic System	...	...	...	...	...	...	...	...	...	...	...
Hemorrhages	...	...	...	...	...	...	...	...	...	...	...

TABLE I.

TO THE INTERNATIONAL CLASSIFICATION OF DEATHS.

F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	Grand Total....
																	Over				
10	10	15	15	20	20	30	30	40	40	50	50	60	60	70	70	80	80	80	Total		
2	3	...	7	2	52	4	31	4	3	3	4	...	1	...	1	1	...	...	106	22	128
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	1	1
...	...	2	...	1	3	...	...	...	...	1	...	...	...	...	...	...	...	...	10	7	17
15	3	2	3	1	1	2	...	2	...	...	...	...	...	...	...	...	...	...	38	42	80
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	8	5	13
30	10	9	7	2	9	1	6	...	1	...	...	...	...	...	...	...	...	...	81	67	148
1	...	...	1	2	2	1	1	...	1	1	1	...	5	2	3	1	2	1	18	10	28
...	...	...	...	...	...	...	1	...	2	1	...	1	...	...	...	...	...	...	3	2	5
...	...	...	...	...	1	1	5	2	3	...	3	2	4	2	2	...	1	...	24	16	40
...	...	...	1	...	3	1	7	...	5	1	4	4	4	1	1	...	...	...	26	8	34
...	1	3	6	5	41	20	49	14	61	7	41	5	12	2	2	4	1	1	218	63	281
1	1	...	1	...	1	...	1	...	...	1	...	...	...	...	...	...	...	...	5	9	14
...	...	1	1	...	2	1	...	1	...	...	...	...	...	...	...	...	...	...	3	5	8
...	1	...	1	...	4	...	1	1	...	...	...	...	1	...	...	...	...	...	11	1	12
...	...	...	...	...	...	...	...	...	1	1	...	...	1	...	...	...	...	...	3	1	4
...	...	...	...	...	1	1	4	2	5	7	17	4	10	7	6	6	2	...	45	27	72
...	...	...	...	...	...	...	1	1	5	...	...	...	1	1	1	1	2	...	10	3	13
...	...	...	...	...	...	...	...	2	...	7	...	5	...	6	...	6	...	1	...	27	27
...	...	...	...	...	...	1	...	...	1	2	6	1	2	...	1	...	2	...	14	4	18
...	...	...	...	...	...	...	...	1	1	...	3	2	1	...	2	...	...	...	7	3	10
1	...	2	1	...	2	2	...	...	...	...	1	...	...	...	1	1	...	...	7	6	13
...	...	...	...	...	...	...	...	...	1	1	...	...	3	...	...	1	...	...	4	2	6
1	3	...	1	1	2	1	1	...	1	2	3	1	7	...	2	...	1	...	22	6	28
...	...	...	...	...	...	...	...	1	2	2	1	1	...	1	1	...	1	...	8	7	15
...	...	...	...	...	8	...	20	2	33	1	23	...	11	...	2	...	1	...	98	3	101
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	1	1	2	...	...	...	1	...	...	...	...	...	...	...	4	1	5
...	...	...	...	...	...	1	...	...	...	1	...	...	...	...	...	1	...	...	...	3	3
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	2	3
2	...	...	...	...	...	1	1	...	...	...	1	...	...	...	1	...	...	...	5	5	10
4	8	...	3	1	5	3	2	2	...	...	...	...	...	...	...	...	...	...	48	34	82
...	...	...	...	1	6	1	2	2	11	1	21	7	26	7	19	6	2	3	87	28	115
...	...	...	...	...	...	...	...	...	2	...	...	...	2	1	2	1	...	...	6	2	8
...	...	...	...	...	...	...	3	2	4	1	7	1	6	3	2	6	1	...	23	13	36
...	...	...	...	...	2	1	3	...	7	1	4	1	2	3	5	1	...	...	23	7	30
...	1	...	...	1	2	1	2	1	1	...	2	...	1	...	...	...	...	...	10	3	13
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	17	11	28
...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	1	...	1
2	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	1	...	...	1	3	4
1	1	...	...	...	...	2	1	1	2	1	...	...	3	...	2	1	...	...	9	9	18
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	1	...	...	...	...	...	1	...	1	...	...	...	...	...	...	...	6	1	7
1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	1
6	1	8	6	4	13	7	23	12	31	9	33	11	40	9	22	13	...	...	182	81	263
...	...	...	1	...	1	...	1	1	2	2	5	2	...	2	6	6	...	1	17	14	31
...	...	...	...	...	1	...	1	...	3	...	2	...	1	...	2	...	1	1	11	1	12
...	...	...	...	...	...	...	...	...	1	...	...	...	1	...	3	...	...	...	5	...	5
...	...	...	...	1	...	1	...	1	1	...	...	...	...	...	1	1	...	...	2	4	6
...	...	...	...	...	...	...	...	1	1	...	...	...	...	...	...	...	...	...	1	1	2
...	...	...	...	...	1	...	...	...	...	...	1	...	...	...	...	...	...	...	2	...	2

TABLE I. (Continued.)

SHOWING DEATHS BY AGE AND SEX ARRANGED ACCORDING

SEX.	M	F	M	F	M	F	M	F	M	F	M
	Under										
AGE.	1	1	1	2	2	3	3	4	4	5	5
IV.											
DISEASES OF RESPIRATORY SYSTEM.											
Diseases of Larynx	...	...	...	...	...	...	...	...	...	...	1
Bronchitis, Acute	7	9	1	1	1	2	...	1	...	...	1
Bronchitis, Chronic	...	...	...	...	...	...	...	...	...	...	...
Phenumonia	39	35	8	16	9	3	...	4	1	1	3
Pleurisy	...	...	...	...	...	...	...	...	...	...	...
Pulmonary Congestion and Apoplexy	...	...	...	...	...	...	...	...	...	...	...
Asthma	...	...	...	...	...	...	...	...	...	...	...
Pulmonary Emphysema	...	...	...	...	...	...	...	...	...	...	...
Empyema	1	...	...	1	...	...	...	...	...	...	1
Other Diseases of Respiratory System	...	...	...	...	...	...	...	...	...	...	...
V.											
DISEASES OF DIGESTIVE SYSTEM.											
Ulcer of Stomach	...	...	...	...	...	...	...	...	...	...	...
Other Diseases of Stomach	...	...	...	...	...	...	...	...	...	...	...
Diarrhoea and Enteritis, under 2 years	64	58	15	11	...	...	...	...	...	...	...
Diarrhoea and Enteritis, Chronic	...	...	...	...	...	...	...	...	...	...	...
Diarrhoea and Enteritis, over 2 years	...	...	...	...	13	2	4	4	2	...	1
Hernia and Intestinal Obstruction	...	...	1	...	1	1	...	...	...	...	1
Cirrhosis of Liver	...	...	...	...	...	...	...	...	...	...	...
Billiary Calculi	...	...	...	...	...	...	...	...	...	...	...
Other Diseases of Liver	...	...	...	...	...	...	...	...	...	...	...
Diseases of Spleen	...	...	...	...	...	...	...	...	...	...	...
Peritonitis, Simple	1	1	...	...	...	...	...	...	...	...	2
Other Diseases of Digestive System	...	...	...	...	...	...	...	...	...	...	...
Appendicitis and Abscess of Iliac Fossa	...	...	...	...	...	...	...	...	...	...	2
Pyosalpinx	...	...	...	...	...	...	...	...	...	...	...
VI.											
DISEASES OF G. U. SYSTEM AND ADENEXA.											
Nephritis, Acute	2	...	1	...	...	1	...	1	1	...	2
Bright's Disease	...	...	...	...	...	...	...	...	...	...	2
Diseases of Bladder	...	...	...	...	...	...	...	...	...	...	...
Diseases of Prostate	...	...	...	...	...	...	...	...	...	...	...
Endometritis	...	...	...	...	...	...	...	...	...	...	...
VII.											
THE PUERPERAL STATE.											
Accidents of Pregnancy	...	...	...	...	...	...	...	...	...	...	...
Accidents of Labor	...	...	...	...	...	...	...	...	...	...	...
Septicaemia, Puerperal	...	...	...	...	...	...	...	...	...	...	...
Albuminuria and Eclampsia	...	...	...	...	...	...	...	...	...	...	...
VIII.											
DISEASES OF SKIN AND CELLULAR TISSUE.											
Gangrene	...	...	...	...	...	...	...	...	...	...	...
Carbuncle	...	...	...	...	...	...	...	...	...	...	...
IX.											
EARLY INFANCY.											
Congenital Debility, Icterus, Scleroma	149	125	...	...	...	...	...	...	...	...	...

TABLE I. (Continued.)

TO THE INTERNATIONAL CLASSIFICATION OF DEATHS.

F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	Grand Total....
																	Over				
10	10	15	15	20	20	30	30	40	40	50	50	60	60	70	70	80	80	80	Total		
...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	1	1	2
...	...	...	...	...	...	1	1	...	...	...	...	...	2	...	...	1	1	1	14	16	30
...	...	...	...	...	...	...	2	...	1	...	1	...	2	2	1	...	1	1	8	3	11
5	...	2	11	3	32	13	42	18	50	10	50	13	24	13	27	10	6	5	302	151	453
...	...	...	...	...	1	...	...	...	...	...	1	...	...	...	...	...	...	1	2	1	3
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	1	1	...	3	...	4	...	3	...	3	1	14	2	16
...	...	...	...	...	...	...	1	...	1	...	...	...	...	...	1	...	...	...	3	...	3
...	...	...	...	...	...	...	1	...	1	...	1	...	...	...	...	...	...	...	5	1	6
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	1	1	...	...	...	1	...	...	...	1	...	...	...	3	1	4
...	...	...	...	1	...	...	2	...	3	...	1	1	...	2	4	1	1	...	11	5	16
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	79	69	148
...	...	...	...	...	...	...	...	...	1	3	1	...	3	1	4	...	...	1	9	5	14
...	1	1	...	...	1	1	1	...	1	1	1	...	1	...	1	...	1	1	28	10	38
...	...	...	2	...	4	1	2	4	1	1	3	...	2	...	4	3	...	...	21	10	31
...	...	...	...	...	...	...	2	...	4	1	5	...	8	1	2	...	...	...	21	2	23
...	...	...	...	...	1	1	...	...	...	1	...	1	...	1	1	1	...	...	2	5	7
...	...	...	...	...	2	...	...	1	1	...	...	...	1	1	1	...	1	1	6	3	9
...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	1
1	1	1	2	2	3	3	4	2	4	2	1	..	1	2	1	1	...	...	20	15	35
...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	1	...	1
4	4	1	1	1	8	5	6	5	4	1	1	1	...	1	...	...	...	...	26	19	45
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	1	1	3	...	2	1	1	1	...	1	2	...	1	1	...	...	1	...	17	7	24
1	...	1	3	1	7	1	13	12	17	10	16	9	24	13	18	4	4	5	104	57	161
...	...	...	...	...	...	...	...	...	...	...	2	...	1	...	5	...	1	...	9	...	9
...	...	...	...	...	...	...	...	...	...	...	...	..	1	...	2	...	3	...	6	...	6
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	1	...	2	...	...	...	...	...	...	...	...	...	...	...	3	3
...	...	...	...	...	...	6	...	3	...	1	...	...	...	...	...	...	...	...	...	10	10
...	...	...	...	8	...	27	...	15	...	4	...	...	...	...	...	...	...	...	...	54	54
...	...	...	...	...	...	10	...	1	...	...	...	...	...	...	...	...	...	...	...	11	11
...	...	...	...	...	...	...	1	...	...	...	1	...	2	...	4	1	...	...	8	1	9
...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	1	...	1
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	149	125	274

TABLE I.—(Continued.)

SHOWING DEATHS BY AGE AND SEX ARRANGED ACCORDING

SEX.	M	F	M	F	M	F	M	F	M	F	M
	Under										
AGE.	1	1	1	2	2	3	3	4	4	5	5
X.											
OLD AGE.											
Senile Debility	...	...	...	...	...	...	...	...	...	...	...
XI.											
AFFECTIONS PRODUCED BY EXTERNAL CAUSES.											
Suicide, by Poisoning	...	...	...	...	...	...	...	...	...	...	...
Suicide, by Hanging and Strangulation	...	...	...	...	...	...	...	...	...	...	...
Suicide, by Drowning	...	...	...	...	...	...	...	...	...	...	...
Suicide, by Firearms	...	...	...	...	...	...	...	...	...	...	...
Suicide, by Cutting Instruments	...	...	...	...	...	...	...	...	...	...	...
Other Suicides	...	...	...	...	...	...	...	...	...	...	...
Accidents with Firearms	...	...	...	...	2	...	...	...	...	...	1
Railroad Accidents	...	...	...	...	...	...	...	...	...	...	2
Mill Accidents	...	...	...	...	...	...	...	...	...	...	...
Accidents with Horses and Vehicles	...	...	...	...	1	...	...	...	1	...	2
Mine Accidents	...	...	...	...	...	...	...	...	...	...	...
Other Accidental Traumatisms	2	1	...	...	1	...	...	...	...	...	1
Burns and Scalds	1	...	1	...	2	...	1	1	...	...	...
Isolation and Freezing	3	...	...	...	...	...	...	...	...	...	...
Electrical, Other than Lightning	...	...	...	...	...	...	...	...	...	...	...
Lightning	...	...	...	...	...	...	...	...	...	...	...
Accidental Poisoning	1	1	1	2	1	2	...	...	...	...	...
Accidental Drowning	...	...	2	1	...	...	2	...	...	1	2
Homicide	...	...	...	...	...	...	...	...	1	...	...
Auto Accident	...	...	...	...	...	...	...	...	...	...	...
Chloroform	...	...	...	...	...	...	...	...	...	...	...
Legal Execution	...	...	...	...	...	...	...	...	...	...	...
XII.											
DEATHS FROM ILL-DEFINED CAUSES AND STILLBIRTHS.											
Dropsy	...	...	...	...	...	...	...	...	...	...	...
Unspecified or ill-defined	1	...	...	...	...	...	...	...	1	...	1
Stillbirths	157	97	...	...	...	...	...	...	...	...	...
Total	472	376	59	54	57	29	21	32	31	20	79

Annual Death Rate Per Thousand Population, 15.5.

TABLE I.—(Continued.)

TO THE INTERNATIONAL CLASSIFICATION OF DEATHS.

F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	Grand Total....
																	Over				
10	10	15	15	20	20	30	30	40	40	50	50	60	60	70	70	80	80	80	Total		
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	17	7	24	19	41	26	67
...	...	1	2	3	5	6	2	5	2	...	4	...	...	1	1	...	...	...	16	16	32
...	...	...	...	...	1	...	1	...	1	...	...	...	2	...	...	...	...	...	5	...	5
...	...	...	...	...	1	...	...	...	1	...	...	...	...	...	...	...	...	...	2	...	2
...	...	...	...	...	9	...	11	...	6	...	1	...	2	...	...	...	...	...	29	...	29
...	...	...	...	...	2	...	...	...	4	...	3	...	1	...	1	...	...	...	11	...	11
...	...	...	...	...	1	...	...	...	...	1	...	...	...	...	...	...	...	...	1	1	2
...	5	...	3	...	13	1	5	...	1	...	2	...	1	...	...	...	...	...	33	1	34
...	1	...	9	1	59	...	61	...	44	...	8	...	2	...	1	...	...	...	187	1	188
...	...	...	...	...	1	...	...	...	2	...	...	...	...	...	...	...	...	...	3	...	3
...	2	...	5	...	10	...	7	...	7	1	6	...	3	...	1	...	...	...	45	1	46
...	...	...	1	...	23	...	16	...	11	...	2	...	1	...	1	...	...	...	55	...	55
1	3	...	4	...	18	...	16	1	12	...	6	1	4	2	1	1	1	...	69	7	76
2	...	...	...	...	2	...	1	1	2	1	2	...	...	...	1	...	...	...	13	5	18
...	...	...	1	...	3	...	2	...	4	...	3	...	...	...	...	...	...	...	16	...	16
...	...	...	...	...	1	...	1	...	...	...	...	...	...	...	...	...	...	...	2	...	2
...	1	...	...	...	3	...	2	...	...	...	...	...	...	...	...	...	...	...	6	...	6
...	1	...	...	...	1	2	2	1	...	2	2	...	...	...	...	...	...	...	9	10	19
3	6	...	...	2	23	...	26	1	12	...	4	...	1	...	2	...	...	...	80	8	88
2	...	2	...	...	16	2	14	1	16	1	3	...	3	...	1	...	...	...	54	8	62
...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	1
...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	1
...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	1
...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	1	1
2	...	1	...	1	8	7	8	...	5	3	10	4	10	3	4	2	2	2	50	25	75
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	157	97	254
98	59	38	89	46	427	145	425	132	418	99	333	79	254	91	201	90	67	47	2987	1366	4353

TABLE II.

Showing number of deaths (exclusive of Still-Births) from principal causes for the year ending November 30, 1908, arranged according to counties. Also showing deaths from principal causes in cities of 5,000 or more inhabitants.

DECEMBER, 1907.

	Smallpox	Tuberculosis	Diphtheria	Scarlet Fever	Measles	Typhoid Fever	Whooping Cough	Meningitis	Pneumonia	Nephritis	Organic Heart Disease	Malignant Tumors	Acute Intestinal Diseases	Violence	Suicide	Alcoholism	All Other Causes	Totals
Beaverhead	...	...	...	...	...	1	...	...	...	...	...	2	...	4	...	...	1	8
Broadwater	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	1
Carbon	...	...	1	...	...	...	...	...	4	1	...	...	...	1	...	...	7	14
Cascade	...	2	...	2	...	4	...	...	2	1	1	...	...	2	...	...	6	20
Chouteau	...	...	...	...	...	...	...	...	1	...	1	...	...	...	...	...	4	6
Custer	...	...	...	...	...	1	...	...	1	...	...	...	...	1	...	1	1	5
Dawson	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	3	4
Deer Lodge	...	2	...	1	...	...	...	1	3	1	4	1	...	2	...	...	15	30
Fergus	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	2	1	4
Flathead	...	4	2	...	...	...	...	...	1	2	2	1	...	5	1	...	10	28
Gallatin	...	1	...	...	...	...	...	...	...	4	...	1	...	1	...	...	3	10
Granite	...	...	...	...	...	...	...	...	...	1	1	...	1	3	...	...	...	6
Jefferson	...	1	...	...	...	...	...	...	1	...	...	...	...	1	...	...	1	4
Lewis and Clark	...	3	...	...	...	2	...	...	6	...	2	1	...	2	1	2	7	26
Madison	...	...	...	...	...	1	...	...	4	...	...	1	...	1	...	...	3	10
Meagher	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	1	1	3
Missoula	...	3	1	...	...	7	...	3	8	1	4	1	...	11	1	...	10	50
Park	...	2	...	...	...	...	...	1	2	...	1	1	...	...	...	...	4	11
Powell	...	...	...	...	...	...	...	...	1	1	2	...	...	1	...	...	...	5
Ravalli	...	...	...	1	...	...	...	...	3	1	...	...	1	...	1	...	4	11
Rosebud	...	...	2	...	...	...	...	...	2	...	...	...	...	1	...	...	...	5
Sanders	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	1	2
Silver Bow	...	8	...	1	...	1	...	2	13	2	7	5	...	7	3	1	22	72
Sweetgrass	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Teton	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Valley	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	2	3
Yellowstone	...	1	...	...	1	...	...	...	6	1	2	...	...	4	...	...	4	19
Totals	...	27	6	5	1	18	...	7	58	16	28	14	2	49	8	8	110	357

DEATHS FROM PRINCIPAL CAUSES IN CITIES OF 5,000 OR MORE INHABITANTS.

	Smallpox	Tuberculosis	Diphtheria	Scarlet Fever	Measles	Typhoid Fever	Whooping Cough	Meningitis	Pneumonia	Nephritis	Organic Heart Disease	Malignant Tumors	Acute Intestinal Diseases	Violence	Suicide	Alcoholism	All Other Causes	Totals
Anaconda	...	2	...	1	...	...	...	1	3	...	4	1	...	2	...	...	7	21
Billings	...	1	...	...	1	...	...	...	5	1	1	...	...	2	...	...	4	15
Bozeman	...	1	...	...	...	...	...	...	...	3	...	1	...	1	...	...	1	7
Butte	...	5	...	1	...	1	...	1	8	2	4	1	...	3	2	1	15	44
Great Falls	...	2	...	2	...	4	...	...	1	1	1	...	...	2	...	...	4	17
Helena	...	3	...	...	...	2	...	...	3	...	2	1	...	...	1	2	5	19
Livingston	...	2	...	...	...	...	...	...	1	...	...	1	...	...	...	...	2	6
Missoula	...	3	...	...	...	6	...	1	5	1	...	...	...	4	1	...	7	28

TABLE II—(Continued.)

JANUARY, 1908.

	Smallpox	Tuberculosis	Diphtheria	Scarlet Fever	Measles	Typhoid Fever	Whooping Cough	Meningitis	Pneumonia	Nephritis	Organic Heart Disease	Malignant Tumors	Acute Intestinal Diseases	Violence	Suicide	Alcoholism	All Other Causes	Totals
Beaverhead	...	...	...	...	...	...	...	...	1	...	...	...	...	3	...	...	1	5
Broadwater	...	...	...	...	...	...	...	...	3	1	1	...	...	...	...	...	1	6
Carbon	...	3	...	...	...	2	...	...	4	...	...	...	...	1	...	...	2	12
Cascade	...	1	3	3	...	1	2	...	4	...	...	...	...	2	...	...	11	27
Chouteau	...	2	...	...	...	...	...	...	2	...	1	...	1	2	...	...	5	13
Custer	...	...	1	...	...	1	...	...	3	2	1	...	...	...	...	1	...	9
Dawson	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	2	3
Deer Lodge	...	2	...	...	...	...	...	2	4	3	...	...	...	...	...	1	9	21
Fergus	...	...	...	...	...	...	...	...	1	...	...	2	...	9	...	...	...	12
Flathead	...	1	1	...	...	...	...	...	6	1	1	2	...	1	...	1	5	19
Gallatin	...	1	...	...	...	...	...	...	...	2	...	...	...	2	1	1	9	16
Granite	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	1	1	3
Jefferson	...	1	...	...	...	...	...	...	2	...	...	...	...	1	...	1	9	14
Lewis and Clerk	...	2	2	...	...	...	...	1	11	3	1	1	...	5	1	1	15	43
Madison	...	...	...	...	...	...	...	1	1	...	1	1	1	3	...	...	6	14
Meagher	...	1	...	...	...	...	...	...	2	...	...	...	...	...	...	1	2	6
Missoula	...	...	1	...	...	3	...	2	12	2	2	...	...	7	...	2	8	39
Park	...	1	1	...	...	...	...	...	5	...	3	1	...	...	...	...	5	16
Powell	...	2	...	...	...	...	...	...	3	1	1	...	...	1	...	...	1	9
Ravalli	...	...	...	1	...	...	...	1	2	1	3	...	...	...	...	...	4	12
Rosebud	...	...	...	...	...	...	...	...	1	...	...	...	1	...	...	...	1	3
Sanders	...	...	1	...	...	...	...	...	...	...	...	2	...	5	...	...	2	10
Silver Bow	...	7	1	2	...	1	...	5	15	6	7	3	...	6	...	2	29	84
Sweetgrass	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	1
Teton	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	1
Valley	...	1	...	...	...	...	...	...	1	...	1	...	...	...	...	1	1	5
Yellowstone	...	...	4	...	2	4	...	...	9	...	4	2	...	2	...	...	8	35
Totals	...	25	16	6	2	12	2	12	92	22	27	14	3	51	2	13	139	438

DEATHS FROM PRINCIPAL CAUSES IN CITIES OF 5,000 OR MORE INHABITANTS.

Anaconda	...	2	...	...	...	...	...	2	2	1	...	...	...	...	...	1	6	14
Billings	...	...	2	...	1	4	...	...	7	...	4	2	...	2	...	...	8	30
Bozeman	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	5	6
Butte	...	4	1	2	...	1	...	4	13	6	5	3	...	2	...	2	24	67
Great Falls	...	1	...	2	...	1	...	...	3	...	...	...	...	1	...	...	4	12
Helena	...	2	2	...	...	...	...	1	9	3	1	1	...	1	1	1	13	35
Livingston	...	...	...	...	...	...	...	...	3	...	3	...	...	...	...	...	5	11
Missoula	...	...	1	...	...	2	...	1	11	1	1	...	...	3	...	...	4	24

TABLE II—(Continued.)

FEBRUARY, 1908.

	Smallpox	Tuberculosis	Diphtheria	Scarlet Fever	Measles	Typhoid Fever	Whooping Cough	Meningitis	Pneumonia	Nephritis	Organic Heart Disease	Malignant Tumors	Acute Intestinal Diseases	Violence	Suicide	Alcoholism	All Other Causes	Totals
Beaverhead	...	...	...	...	...	1	...	...	1	...	1	...	...	...	...	...	1	4
Broadwater	...	...	...	...	...	...	...	...	2	...	...	...	...	...	...	...	2	4
Carbon	...	1	2	...	1	1	...	...	2	...	...	...	...	...	...	2	4	13
Cascade	...	2	8	2	...	...	1	2	1	2	1	1	...	2	2	2	12	38
Chouteau	...	1	...	...	...	...	...	1	1	...	1	...	...	...	...	...	2	6
Custer	...	...	1	...	...	...	...	...	...	...	1	...	...	1	...	...	5	8
Dawson	...	...	...	2	...	...	...	...	1	...	...	...	1	...	...	...	2	6
Deer Lodge	...	1	...	1	...	...	...	2	1	1	2	1	...	...	...	1	9	19
Fergus	...	...	...	...	...	1	...	...	5	1	2	...	1	1	...	2	5	18
Flathead	...	...	...	1	1	...	...	2	3	...	1	1	...	1	...	2	4	16
Gallatin	...	1	1	1	...	...	...	...	4	1	1	1	...	1	...	1	8	20
Granite	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	1
Jefferson	...	...	2	...	...	...	...	...	2	1	1	...	...	...	...	...	2	8
Lewis and Clark	...	3	...	...	...	...	...	...	3	...	2	...	...	3	2	...	6	19
Madison	...	...	...	...	...	...	...	...	3	1	...	...	...	...	...	...	...	4
Meagher	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	1
Missoula	...	1	1	...	...	...	...	2	5	4	5	...	...	7	1	2	9	37
Park	...	...	...	...	...	...	...	...	1	2	1	...	...	2	...	...	4	10
Powell	...	...	...	...	1	...	...	...	1	...	...	...	...	...	...	...	2	4
Ravalli	...	1	...	...	...	...	...	...	4	...	1	1	...	...	...	...	4	11
Rosebud	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	1	2
Sanders	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	4	5
Silver Bow	...	9	3	...	...	...	...	2	7	3	3	4	1	6	1	1	18	58
Sweetgrass	...	...	...	...	...	...	...	...	...	...	1	...	...	1	...	...	1	3
Teton	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Valley	...	2	1	...	...	...	...	...	1	1	...	...	...	...	...	...	2	7
Yellowstone	...	1	...	...	2	...	...	...	3	...	4	2	...	2	1	...	7	22
Totals	...	23	19	7	5	3	1	11	51	17	29	11	3	28	7	13	116	344

DEATHS FROM PRINCIPAL CAUSES IN CITIES OF 5,000 OR MORE INHABITANTS.

	Smallpox	Tuberculosis	Diphtheria	Scarlet Fever	Measles	Typhoid Fever	Whooping Cough	Meningitis	Pneumonia	Nephritis	Organic Heart Disease	Malignant Tumors	Acute Intestinal Diseases	Violence	Suicide	Alcoholism	All Other Causes	Totals
Anaconda	...	1	...	1	...	...	...	2	...	...	1	1	...	...	...	1	2	9
Billings	...	1	...	...	...	...	...	...	1	...	4	2	...	1	1	...	7	17
Bozeman	...	1	...	...	...	...	...	...	1	1	1	...	...	...	...	...	5	9
Butte	...	5	2	...	...	...	...	1	6	3	2	3	1	3	1	1	13	41
Great Falls	...	2	...	1	...	...	...	2	1	2	1	1	...	2	2	...	7	21
Helena	...	3	...	...	...	...	...	...	2	...	2	...	...	2	2	...	4	15
Livingston	...	...	...	...	...	...	...	...	...	1	1	...	...	1	...	...	3	6
Missoula	...	1	...	...	...	...	...	1	3	2	...	...	...	1	1	1	5	15

TABLE II.—(Continued.)

MARCH, 1908.

	Smallpox	Tuberculosis	Diphtheria	Scarlet Fever	Measles	Typhoid Fever	Whooping Cough	Meningitis	Pneumonia	Nephritis	Organic Heart Disease	Malignant Tumors	Acute Intestinal Diseases	Violence	Suicide	Alcoholism	All Other Causes	Totals
Beaverhead	...	...	...	2	...	...	...	...	1	...	1	1	...	...	...	...	...	5
Broadwater	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	1	1	3
Carbon	...	2	...	...	...	...	...	...	3	2	1	...	1	1	...	...	8	18
Cascade	...	3	4	1	...	...	4	1	3	1	3	1	...	...	2	...	13	36
Chouteau	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	5	5
Custer	...	...	...	...	...	...	...	...	1	...	...	...	...	...	1	...	5	7
Dawson	...	2	...	...	...	1	...	1	...	...	...	...	1	...	...	...	1	6
Deer Lodge	...	...	...	...	...	...	...	2	2	2	3	1	...	...	...	1	7	18
Fergus	...	1	1	...	...	...	...	...	...	1	1	...	...	1	1	1	3	10
Flathead	...	2	1	...	...	...	...	...	...	1	1	...	...	3	...	...	3	11
Gallatin	...	1	...	...	...	...	...	...	1	3	...	1	...	...	...	...	3	9
Granite	...	...	...	...	...	...	...	...	1	1	...	...	...	...	...	1	1	4
Jefferson	...	1	...	...	...	...	...	...	1	...	1	...	1	2	...	...	1	7
Lewis and Clark	...	1	...	...	...	...	...	...	2	3	3	...	...	1	1	...	6	17
Madison	...	...	...	2	...	...	...	...	...	...	...	1	...	...	...	...	7	10
Meagher	...	...	...	...	...	...	...	...	...	...	1	...	...	1	...	...	...	2
Missoula	...	4	3	...	...	1	1	5	5	2	3	...	1	6	...	1	7	39
Park	...	1	...	...	...	...	...	1	1	...	...	1	1	2	...	...	3	10
Powell	...	2	...	...	...	...	...	...	2	...	1	...	...	2	1	...	1	9
Ravalli	...	1	...	...	...	...	...	...	4	1	...	...	...	...	...	...	2	8
Rosebud	...	...	...	...	1	...	...	...	...	...	...	...	...	1	...	...	...	2
Sanders	...	...	...	...	1	...	...	...	1	...	...	...	...	2	...	...	...	4
Silver Bow	...	6	3	2	...	1	...	2	15	5	8	...	2	6	1	...	13	64
Sweetgrass	...	...	...	...	...	...	...	...	1	...	...	1	...	...	...	...	...	2
Teton	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	1
Valley	...	...	1	...	...	...	...	...	...	1	...	...	...	1	...	...	3	6
Yellowstone	...	1	3	...	1	3	...	...	1	...	...	2	...	5	...	...	5	21
Totals	...	28	16	7	3	6	5	12	46	23	27	9	7	35	7	5	98	334

DEATHS FROM PRINCIPAL CAUSES IN CITIES OF 5,000 OR MORE INHABITANTS.

Anaconda	...	...	...	...	...	...	...	2	2	...	2	1	...	...	...	1	2	10
Billings	...	1	1	...	...	1	...	...	1	...	...	2	...	...	...	...	3	9
Bozeman	...	1	...	...	...	...	...	...	...	2	...	1	...	...	...	...	2	6
Butte	...	4	2	...	...	...	...	1	9	4	6	...	1	1	1	...	8	37
Great Falls	...	3	3	...	...	...	3	1	1	1	2	1	...	...	1	...	11	27
Helena	...	1	...	...	...	...	...	...	2	2	3	...	...	1	1	...	5	15
Livingston	...	1	...	...	...	...	...	1	...	...	...	1	1	1	...	...	3	8
Missoula	...	3	1	...	...	1	...	5	3	2	2	...	...	1	...	1	5	24

TABLE II.—(Continued.)

APRIL, 1908.

	Smallpox	Tuberculosis	Diphtheria	Scarlet Fever	Measles	Typhoid Fever	Whooping Cough	Meningitis	Pneumonia	Nephritis	Organic Heart Disease	Malignant Tumors	Acute Intestinal Diseases	Violence	Suicide	Alcoholism	All Other Causes	Totals
Beaverhead	...	1	...	...	...	...	...	...	...	1	2	1	...	...	...	1	....	6
Broadwater	...	...	...	...	...	...	...	...	1	1	1	...	...	...	...	...	1	4
Carbon	...	...	...	...	...	...	...	2	2	...	2	...	1	...	...	...	1	8
Cascade	...	2	1	...	...	1	...	...	1	2	3	...	...	1	2	...	13	26
Chouteau	...	...	1	...	...	...	...	...	...	...	...	...	...	2	...	1	1	5
Custer	...	...	...	...	...	...	...	...	3	...	...	...	...	1	...	1	1	6
Dawson	...	1	...	...	...	...	...	...	...	1	...	...	...	2	1	...	....	5
Deer Lodge	...	...	...	...	...	...	...	...	4	1	2	...	...	2	...	...	13	22
Fergus	...	...	...	...	...	...	...	1	...	...	...	...	3	...	2	1	2	9
Flathead	...	1	...	...	...	...	...	1	...	...	3	1	...	5	...	...	10	21
Gallatin	...	...	...	...	...	...	...	2	...	1	...	...	1	2	...	...	4	10
Granite	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	1	2
Jefferson	...	...	...	...	...	...	...	...	1	...	1	...	...	...	...	...	3	5
Lewis and Clark	...	4	1	...	...	...	...	...	4	2	2	...	...	2	...	...	7	22
Madison	...	...	...	1	...	...	...	...	1	...	...	...	1	2	...	1	5	11
Meagher	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	2	3
Missoula	...	4	1	1	...	...	2	...	5	1	1	2	...	4	1	...	6	28
Park	...	1	...	...	...	...	...	1	...	...	...	...	1	3	...	...	5	11
Powell	...	...	...	...	...	2	...	...	2	1	...	...	...	3	...	...	1	9
Ravalli	...	...	...	...	...	...	1	...	2	...	2	1	...	...	...	...	3	9
Rosebud	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	....	1
Sanders	...	...	...	...	...	...	...	...	...	1	...	...	...	1	...	...	....	2
Silver Bow	...	5	...	4	...	1	...	7	18	3	7	1	1	3	...	2	33	85
Sweetgrass	...	1	...	...	...	...	...	...	1	...	...	...	...	...	...	...	....	2
Teton	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	....	1
Valley	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	....	1
Yellowstone	...	1	2	1	2	...	...	...	4	1	1	...	...	1	1	...	11	25
Totals	...	21	7	7	2	4	3	14	49	17	27	7	8	35	8	7	123	339

DEATHS FROM PRINCIPAL CAUSES IN CITIES OF 5,000 OR MORE INHABITANTS.

	Smallpox	Tuberculosis	Diphtheria	Scarlet Fever	Measles	Typhoid Fever	Whooping Cough	Meningitis	Pneumonia	Nephritis	Organic Heart Disease	Malignant Tumors	Acute Intestinal Diseases	Violence	Suicide	Alcoholism	All Other Causes	Totals
Anaconda	...	...	...	...	...	...	...	...	4	1	1	...	...	2	...	...	5	13
Billings	...	1	2	...	...	...	...	...	4	1	1	...	...	1	1	...	7	18
Bozeman	...	...	...	...	...	...	...	2	...	1	...	...	...	1	...	...	3	7
Butte	...	3	...	3	...	...	...	2	10	3	5	1	...	2	...	1	19	49
Great Falls	...	2	...	...	...	1	...	...	1	2	2	...	...	1	2	...	7	18
Helena	...	4	1	...	...	...	...	...	3	1	1	...	...	...	...	...	6	16
Livingston	...	...	...	...	...	...	...	...	...	...	...	...	...	2	...	...	5	7
Missoula	...	1	...	...	...	...	2	...	5	...	1	1	...	1	1	...	2	14

TABLE II.—(Continued.)
MAY, 1908.

	Smallpox	Tuberculosis	Diphtheria	Scarlet Fever	Measles	Typhoid Fever	Whooping Cough	Meningitis	Pneumonia	Nephritis	Organic Heart Disease	Malignant Tumors	Acute Intestinal Diseases	Violence	Suicide	Alcoholism	All Other Causes	Totals
Beaverhead	...	...	...	1	...	...	...	...	...	...	...	...	1	...	...	...	....	2
Broadwater	...	...	1	...	...	...	...	...	...	1	...	...	...	...	...	...	1	3
Carbon	...	2	...	...	...	...	...	1	1	...	1	1	...	1	1	...	4	12
Cascade	...	2	1	...	...	...	...	1	3	1	7	...	...	4	...	...	6	25
Chouteau	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2	...	2	4
Custer	...	1	2	...	...	...	...	...	2	...	1	...	...	1	...	...	4	11
Dawson	...	...	1	...	...	1	...	...	...	...	...	...	...	...	...	...	2	4
Deer Lodge	...	2	...	...	...	...	...	...	...	...	3	2	...	...	...	...	9	16
Fergus	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	4	5
Flathead	...	...	1	...	...	...	...	1	...	5	...	...	1	1	...	...	7	16
Gallatin	...	...	...	...	...	...	...	1	2	...	...	...	...	1	...	...	1	5
Granite	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	3	4
Jefferson	...	1	...	...	...	...	...	...	...	...	...	1	...	1	...	...	2	5
Lewis and Clark	...	1	1	...	...	...	...	1	2	...	3	...	...	1	...	...	4	13
Madison	...	...	...	...	...	...	...	...	...	...	3	...	2	...	...	...	3	8
Meagher	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	....	....
Missoula	...	2	3	...	...	...	1	2	3	...	1	...	...	10	1	1	9	33
Park	...	...	...	1	...	...	...	...	1	1	3	...	...	...	1	1	3	11
Powell	...	...	...	...	...	...	...	1	1	...	1	1	...	...	1	...	2	7
Ravalli	...	1	...	1	...	...	...	...	...	...	2	1	1	1	...	1	6	14
Rosebud	...	...	...	...	...	...	...	...	2	...	...	...	...	1	...	...	....	3
Sanders	...	...	...	...	...	...	...	...	...	...	...	...	...	4	...	...	....	4
Silver Bow	...	10	4	5	...	...	...	1	8	...	6	2	1	10	2	2	15	66
Sweetgrass	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	1	2
Teton	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2	2
Valley	...	1	...	...	...	1	...	...	1	...	1	...	1	1	...	...	3	9
Yellowstone	...	1	...	...	...	...	...	...	1	4	1	1	1	2	1	...	9	21
Totals	...	24	14	8	...	2	1	9	29	12	33	10	8	39	9	5	102	305

DEATHS FROM PRINCIPAL CAUSES IN CITIES OF 5,000 OR MORE INHABITANTS.

	Smallpox	Tuberculosis	Diphtheria	Scarlet Fever	Measles	Typhoid Fever	Whooping Cough	Meningitis	Pneumonia	Nephritis	Organic Heart Disease	Malignant Tumors	Acute Intestinal Diseases	Violence	Suicide	Alcoholism	All Other Causes	Totals
Anaconda	...	2	...	...	...	...	...	...	...	...	2	2	...	...	...	...	7	13
Billings	...	...	...	...	...	...	...	...	1	2	1	1	...	...	1	...	4	10
Bozeman	...	...	...	...	...	...	...	...	2	...	...	...	...	...	...	...	1	3
Butte	...	6	3	5	...	...	...	1	5	...	5	2	1	4	2	...	8	42
Great Falls	...	2	...	...	...	...	...	1	2	1	5	...	...	3	...	...	6	20
Helena	...	1	1	...	...	...	...	1	1	...	2	...	...	...	...	...	2	8
Livingston	...	...	...	1	...	...	...	...	...	...	2	...	...	...	1	1	....	5
Missoula	...	1	1	...	...	...	...	2	2	...	1	...	...	...	1	1	3	12

TABLE II.—(Continued.)

June, 1908.

	Smallpox	Tuberculosis	Diphtheria	Scarlet Fever	Measles	Typhoid Fever	Whooping Cough	Meningitis	Pneumonia	Nephritis	Organic Heart Disease	Malignant Tumors	Acute Intestinal Diseases	Violence	Suicide	Alcoholism	All Other Causes	Totals
Beaverhead	...	...	...	1	...	...	...	...	...	1	...	...	...	2	1	...	2	7
Broadwater	...	...	...	...	...	...	...	...	...	...	...	...	...	2	...	...	1	3
Carbon	...	...	4	...	...	...	...	...	...	...	...	...	...	...	...	...	1	5
Cascade	...	1	...	...	...	...	1	...	...	...	2	...	...	7	...	1	9	21
Chouteau	...	1	...	...	...	...	...	...	1	1	...	...	2	...	...	...	1	6
Custer	...	1	1	...	...	...	...	...	...	1	...	...	...	4	...	...	4	11
Dawson	...	1	...	...	...	1	...	1	...	...	...	...	1	1	...	...	...	5
Deer Lodge	...	1	...	...	...	...	...	...	4	1	...	...	...	2	1	1	11	21
Fergus	...	...	...	...	...	...	...	2	...	...	...	1	...	1	...	1	2	7
Flathead	...	...	1	...	...	...	...	...	1	...	1	...	...	4	...	1	12	20
Gallatin	...	1	...	...	...	...	...	...	1	1	...	1	...	...	...	...	5	9
Granite	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	1	1	3
Jefferson	...	...	1	...	...	...	...	...	...	1	...	...	...	1	...	...	1	4
Lewis and Clark	...	3	2	...	...	...	...	...	1	2	5	3	1	4	...	2	5	28
Madison	...	...	...	...	...	...	...	...	...	1	3	2	...	1	...	...	2	9
Meagher	...	...	...	...	...	...	...	1	...	...	...	...	...	2	...	...	2	5
Missoula	...	1	3	1	...	...	...	...	6	...	2	...	...	11	...	1	3	28
Park	...	1	...	...	...	...	...	...	1	...	...	...	...	2	...	1	5	10
Powell	...	...	1	...	...	...	...	...	...	...	...	...	...	3	1	...	1	6
Ravalli	...	...	1	1	...	...	...	...	1	1	1	...	...	1	...	...	6	12
Rosebud	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	1
Sanders	...	...	1	...	...	1	...	...	...	...	1	1	...	2	...	...	1	7
Silver Bow	...	16	3	9	...	...	...	6	5	1	7	2	1	8	...	...	18	76
Sweetgrass	...	1	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	2
Teton	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	1	2
Valley	...	1	...	...	...	...	...	...	1	...	...	...	...	...	1	...	3	6
Yellowstone	...	1	1	...	...	...	...	...	1	...	...	...	...	4	...	...	5	12
Totals	...	31	19	12	...	2	1	10	24	12	22	10	5	63	4	9	102	326

DEATHS FROM PRINCIPAL CAUSES IN CITIES OF 5,000 OR MORE INHABITANTS.

	Smallpox	Tuberculosis	Diphtheria	Scarlet Fever	Measles	Typhoid Fever	Whooping Cough	Meningitis	Pneumonia	Nephritis	Organic Heart Disease	Malignant Tumors	Acute Intestinal Diseases	Violence	Suicide	Alcoholism	All Other Causes	Totals
Anaconda	...	1	...	...	...	...	...	...	3	...	...	...	...	2	1	1	7	15
Billings	...	1	1	...	...	...	...	...	1	...	...	...	...	1	...	...	2	6
Bozeman	...	1	...	...	...	...	...	...	...	1	...	...	...	...	...	...	1	3
Butte	...	8	1	6	...	...	...	6	2	1	3	1	1	3	...	...	14	46
Great Falls	...	1	...	...	...	...	...	...	...	...	1	...	...	2	...	1	8	13
Helena	...	3	1	...	...	...	...	...	1	1	5	3	...	3	...	2	4	23
Livingston	...	1	...	...	...	...	...	...	1	...	...	...	...	1	...	1	3	7
Missoula	...	1	...	...	...	...	...	...	2	...	1	...	...	...	...	...	2	6

TABLE II.—(Continued.)
JULY, 1908.

	Smallpox	Tuberculosis	Diphtheria	Scarlet Fever	Measles	Typhoid Fever	Whooping Cough	Meningitis	Pneumonia	Nephritis	Organic Heart Disease	Malignant Tumors	Acute Intestinal Diseases	Violence	Suicide	Alcoholism	All Other Causes	Totals
Beaverhead	...	...	...	...	...	...	...	...	...	...	1	1	...	3	...	...	1	6
Broadwater	...	...	...	...	...	...	...	...	...	...	...	1	...	1	...	...	...	2
Carbon	...	1	2	...	...	...	...	...	...	...	1	...	...	4	...	...	2	10
Cascade	...	4	1	...	...	1	...	...	2	1	2	...	...	5	...	...	4	20
Chouteau	...	3	...	...	...	...	...	...	...	...	1	...	...	...	2	...	1	7
Custer	...	...	...	...	...	...	...	1	...	1	...	...	...	2	...	...	2	6
Dawson	...	...	...	...	...	...	...	...	1	...	1	...	...	...	...	...	...	2
Deer Lodge	...	1	2	...	...	1	...	...	1	1	1	...	1	2	...	1	13	24
Fergus	...	1	...	...	...	...	...	...	1	...	...	...	...	1	...	...	7	10
Flathead	...	3	...	...	1	1	...	...	...	1	...	...	1	4	1	1	2	15
Gallatin	...	1	...	...	...	...	...	...	...	...	...	1	...	5	...	...	1	8
Granite	...	1	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	2
Jefferson	...	...	...	...	...	...	...	...	...	...	...	...	1	4	...	...	3	8
Lewis and Clark	...	2	1	...	...	...	...	...	2	2	2	...	1	1	...	2	6	19
Madison	...	1	...	...	...	...	...	...	...	...	...	...	...	2	...	...	2	5
Meagher	...	1	...	...	...	...	...	...	1	...	1	...	...	1	...	...	...	4
Missoula	...	1	...	1	...	...	...	...	...	...	2	1	1	9	1	2	8	26
Park	...	1	1	1	...	1	...	...	...	1	1	1	1	1	...	...	...	9
Powell	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1
Ravalli	...	1	...	...	...	...	...	...	2	...	1	...	1	3	...	...	2	10
Rosebud	...	1	...	...	...	...	...	...	1	...	...	...	...	1	1	...	...	4
Sanders	...	...	1	...	...	...	...	...	...	...	...	...	...	2	1	...	1	5
Silver Bow	...	11	...	5	...	1	...	2	4	3	10	3	2	8	1	3	24	77
Sweetgrass	...	2	...	...	...	...	...	...	...	...	...	...	...	2	...	...	...	4
Teton	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Valley	...	1	...	...	1	...	...	...	...	...	1	...	...	9	...	...	1	13
Yellowstone	...	1	...	...	...	...	...	...	...	...	1	...	...	3	...	...	6	11
Totals	...	39	8	7	2	5	...	3	15	10	26	8	9	74	7	9	86	308

DEATHS FROM PRINCIPAL CAUSES IN CITIES OF 5,000 OR MORE INHABITANTS.

	Smallpox	Tuberculosis	Diphtheria	Scarlet Fever	Measles	Typhoid Fever	Whooping Cough	Meningitis	Pneumonia	Nephritis	Organic Heart Disease	Malignant Tumors	Acute Intestinal Diseases	Violence	Suicide	Alcoholism	All Other Causes	Totals
Anaconda	...	1	2	...	...	1	...	...	1	1	1	...	1	2	...	1	5	16
Billings	...	1	...	...	...	...	...	...	...	...	1	...	...	2	...	...	3	7
Bozeman	...	...	...	...	...	...	...	...	...	...	...	1	...	1	...	...	...	2
Butte	...	7	...	2	...	1	...	1	3	1	7	3	2	4	1	2	14	48
Great Falls	...	4	1	...	...	1	...	...	1	1	1	...	...	5	...	...	3	17
Helena	...	2	1	...	...	...	...	...	1	2	1	...	1	1	...	2	3	14
Livingston	...	...	1	1	...	...	...	...	...	1	...	...	...	...	...	...	...	3
Missoula	...	1	...	...	...	...	...	...	...	...	2	...	1	...	...	1	5	10

TABLE II.—(Continued.)

AUGUST, 1908.

	Smallpox	Tuberculosis	Diphtheria	Scarlet Fever	Measles	Typhoid Fever	Whooping Cough	Meningitis	Pneumonia	Nephritis	Organic Heart Disease	Malignant Tumors	Acute Intestinal Diseases	Violence	Suicide	Alcoholism	All Other Causes	Totals
Beaverhead	...	...	...	...	...	...	...	...	...	...	2	...	...	...	...	...	2	4
Broadwater	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	2	3
Carbon	...	...	2	...	...	1	...	...	...	...	1	...	...	1	...	...	2	7
Cascade	...	...	...	...	...	1	...	...	1	...	4	3	2	8	...	1	10	30
Chouteau	...	1	1	...	...	1	...	...	1	...	1	1	1	4	...	1	4	16
Custer	...	...	...	...	...	1	...	...	...	...	1	...	2	1	...	...	1	6
Dawson	...	1	...	...	...	...	...	...	...	...	1	...	2	4	...	...	...	8
Deer Lodge	...	3	1	...	...	...	...	...	...	...	1	1	3	4	...	1	8	22
Fergus	...	...	...	...	...	...	...	...	1	...	...	...	...	2	1	...	4	8
Flathead	...	2	...	...	...	1	...	...	2	1	...	3	1	2	...	2	4	18
Gallatin	...	1	...	...	...	...	...	...	...	...	1	...	2	4	...	...	2	10
Granite	...	...	...	...	...	...	...	...	...	2	1	...	...	...	...	...	2	5
Jefferson	...	...	1	...	...	...	...	...	...	...	...	...	1	...	...	...	1	3
Lewis and Clark	...	2	...	1	...	...	...	...	...	3	2	1	1	2	1	...	5	18
Madison	...	...	...	...	...	...	...	...	1	...	...	...	3	1	...	...	1	6
Meagher	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	1
Missoula	...	2	2	...	...	4	...	1	2	2	1	1	8	9	1	...	9	42
Park	...	...	...	...	...	...	...	...	1	...	...	...	2	1	...	...	2	6
Powell	...	...	...	...	...	1	...	...	1	...	...	3	2	1	...	1	2	11
Ravalli	...	...	...	...	...	...	...	...	...	...	...	...	2	...	...	...	2	4
Rosebud	...	1	...	...	...	...	...	...	1	...	...	...	...	...	...	...	2	4
Sanders	...	...	...	...	...	...	...	...	...	...	1	...	...	2	...	...	...	3
Silver Bow	...	6	3	2	...	3	...	2	4	4	4	2	13	8	...	4	17	72
Sweetgrass	...	...	...	...	...	1	...	...	1	...	...	...	...	...	...	...	...	2
Teton	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	1	2
Valley	...	...	...	...	...	...	...	...	...	...	...	...	5	1	...	...	3	9
Yellowstone	...	1	1	...	...	...	...	...	1	1	2	1	2	1	1	1	5	17
Totals	...	20	11	3	...	14	...	3	18	13	23	17	52	57	4	11	91	337

DEATHS FROM PRINCIPAL CAUSES IN CITIES OF 5,000 OR MORE INHABITANTS.

	Smallpox	Tuberculosis	Diphtheria	Scarlet Fever	Measles	Typhoid Fever	Whooping Cough	Meningitis	Pneumonia	Nephritis	Organic Heart Disease	Malignant Tumors	Acute Intestinal Diseases	Violence	Suicide	Alcoholism	All Other Causes	Totals
Anaconda	...	2	1	...	...	...	...	...	...	...	1	1	2	4	...	1	4	16
Billings	...	1	1	...	...	...	...	...	1	...	1	...	1	1	...	...	2	8
Bozeman	...	...	...	...	...	...	...	...	...	...	1	...	2	...	...	...	2	5
Butte	...	4	...	1	...	2	...	1	...	3	4	2	7	3	...	3	12	42
Great Falls	...	...	...	...	...	1	...	...	1	...	3	3	2	4	...	1	8	23
Helena	...	2	...	1	...	...	...	...	...	2	...	...	1	1	...	...	3	10
Livingston	...	...	...	...	...	...	...	...	...	...	...	...	2	1	...	...	2	5
Missoula	...	2	1	...	...	4	...	1	...	2	1	1	5	3	...	...	4	24

TABLE II.—(Continued.)
SEPTEMBER, 1908.

	Smallpox	Tuberculosis	Diphtheria	Scarlet Fever	Measles	Typhoid Fever	Whooping Cough	Meningitis	Pneumonia	Nephritis	Organic Heart Disease	Malignant Tumors	Acute Intestinal Diseases	Violence	Suicide	Alcoholism	All Other Causes	Totals
Beaverhead	...	...	...	...	...	...	...	...	1	...	1	...	...	...	...	...	3	5
Broadwater	...	...	...	...	...	...	...	...	...	...	...	...	2	...	1	1	2	6
Carbon	...	1	2	...	...	2	...	1	1	1	...	...	7	3	...	...	3	21
Cascade	...	...	...	1	...	2	...	...	4	1	...	...	7	1	1	...	6	23
Chouteau	...	...	...	...	...	...	...	...	...	...	...	...	1	1	...	...	1	3
Custer	...	...	...	...	...	1	...	...	1	...	1	...	2	1	...	...	...	6
Dawson	...	1	...	...	...	...	...	...	...	1	...	...	1	2	...	...	4	9
Deer Lodge	...	...	2	...	...	...	...	...	1	...	2	...	4	...	...	...	5	14
Fergus	...	...	...	...	...	1	...	...	1	...	...	2	2	2	...	...	...	8
Flathead	...	3	...	...	...	3	...	...	...	1	2	2	5	3	...	1	7	27
Gallatin	...	...	...	...	...	1	...	...	1	2	1	1	1	1	1	...	2	11
Granite	...	...	...	...	...	...	...	...	...	...	...	...	1	1	...	...	1	3
Jefferson	...	...	...	...	...	...	...	1	...	...	1	...	...	1	1	...	...	4
Lewis and Clark	...	1	...	...	...	...	...	...	...	2	2	3	3	2	2	...	8	23
Madison	...	...	...	...	...	...	...	...	1	...	2	2	...	1	...	...	5	11
Meagher	...	...	...	...	...	...	...	...	...	...	...	...	...	2	...	...	...	2
Missoula	...	2	2	...	...	8	...	...	2	...	1	1	2	2	1	3	13	37
Park	...	...	...	...	...	...	...	...	...	...	...	1	2	1	1	...	6	11
Powell	...	...	...	...	...	...	...	...	1	1	1	...	...	4	...	...	1	8
Ravalli	...	...	...	...	...	...	...	...	...	...	...	1	3	...	1	...	3	8
Rosebud	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Sanders	...	...	...	...	...	...	...	...	...	...	...	...	1	7	...	...	...	8
Silver Bow	...	9	4	7	...	5	...	2	6	4	4	2	13	9	2	2	24	93
Sweetgrass	...	1	...	...	...	1	...	...	...	...	...	...	...	...	...	1	...	3
Teton	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	1
Valley	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	2	3
Yellowstone	...	3	1	...	...	2	...	...	...	2	...	...	3	23	1	...	4	39
Totals	...	21	11	8	...	26	...	4	20	16	18	15	60	68	12	8	100	387

DEATHS FROM PRINCIPAL CAUSES IN CITIES OF 5,000 OR MORE INHABITANTS.

	Smallpox	Tuberculosis	Diphtheria	Scarlet Fever	Measles	Typhoid Fever	Whooping Cough	Meningitis	Pneumonia	Nephritis	Organic Heart Disease	Malignant Tumors	Acute Intestinal Diseases	Violence	Suicide	Alcoholism	All Other Causes	Totals
Anaconda	...	...	2	...	...	...	...	...	...	...	1	...	4	...	...	...	4	11
Billings	...	2	1	...	...	2	...	...	...	1	...	...	3	5	...	...	3	17
Bozeman	...	...	...	...	...	...	...	...	...	1	...	1	...	...	1	...	1	4
Butte	...	6	1	5	...	3	...	1	3	3	2	2	8	5	1	...	13	53
Great Falls	...	...	...	1	...	2	...	...	2	1	...	...	6	...	1	...	5	18
Helena	...	1	...	...	...	...	...	...	...	2	1	3	2	2	1	...	7	19
Livingston	...	...	...	...	...	...	...	...	...	...	...	...	2	1	...	...	3	6
Missoula	...	2	2	...	...	5	...	...	1	...	1	1	2	1	1	2	7	25

TABLE II.—(Continued.)
OCTOBER, 1908.

	Smallpox	Tuberculosis	Diphtheria	Scarlet Fever	Measles	Typhoid Fever	Whooping Cough	Meningitis	Pneumonia	Nephritis	Organic Heart Disease	Malignant Tumors	Acute Intestinal Diseases	Violence	Suicide	Alcoholism	All Other Causes	Totals
Beaverhead	...	...	1	...	...	1	...	...	1	...	...	...	...	1	...	...	2	6
Broadwater	...	...	...	...	...	...	...	...	...	...	...	1	2	...	...	...	1	4
Carbon	...	1	...	...	...	1	...	2	2	...	...	...	1	3	...	...	2	12
Cascade	...	...	2	...	...	1	...	...	1	1	1	...	1	4	2	1	9	23
Chouteau	...	1	1	...	...	...	...	...	...	3	...	1	...	5	...	...	2	13
Custer	...	1	...	...	...	2	...	...	1	...	2	...	...	...	...	...	1	7
Dawson	...	...	...	...	...	...	...	1	...	...	...	1	...	1	...	1	1	5
Deer Lodge	...	3	...	...	...	...	...	...	...	...	2	...	...	1	...	...	10	16
Fergus	...	2	...	...	1	1	...	...	...	...	...	...	...	2	2	...	1	9
Flathead	...	1	2	...	...	1	...	...	1	...	2	...	1	6	...	...	7	21
Gallatin	...	...	1	...	...	...	...	...	1	1	...	1	3	2	...	...	7	16
Granite	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	1
Jefferson	...	1	...	...	...	...	...	...	...	...	...	1	...	1	...	...	...	3
Lewis and Clark	...	4	...	...	...	...	...	...	2	...	5	...	3	3	3	...	11	31
Madison	...	1	...	...	...	1	...	...	...	...	...	...	...	...	...	...	1	3
Meagher	...	...	...	...	...	...	...	...	...	...	1	...	...	1	1	1	1	5
Missoula	...	2	...	...	...	7	...	...	5	1	...	1	...	7	...	...	8	31
Park	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	4	5
Powell	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	1	2
Ravalli	...	2	...	...	...	...	...	...	1	...	...	1	1	1	...	...	1	7
Rosebud	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Sanders	...	1	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	2
Silver Bow	...	9	2	2	...	4	...	2	7	1	4	5	3	6	...	1	24	70
Sweetgrass	...	...	...	...	...	...	...	...	1	1	...	...	...	1	...	...	...	3
Teton	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	1	2
Valley	...	1	...	...	...	...	...	...	...	...	...	1	...	4	...	...	1	7
Yellowstone	...	1	...	...	...	...	...	...	2	1	...	...	2	1	...	...	6	13
Totals	...	31	9	2	1	19	...	5	25	9	17	13	17	54	9	4	102	317

DEATHS FROM PRINCIPAL CAUSES IN CITIES OF 5,000 OR MORE INHABITANTS.

	Smallpox	Tuberculosis	Diphtheria	Scarlet Fever	Measles	Typhoid Fever	Whooping Cough	Meningitis	Pneumonia	Nephritis	Organic Heart Disease	Malignant Tumors	Acute Intestinal Diseases	Violence	Suicide	Alcoholism	All Other Causes	Totals
Anaconda	...	3	...	...	...	...	...	...	...	...	...	...	...	1	...	...	7	11
Billings	...	1	...	...	...	...	...	...	1	1	...	...	1	...	...	...	5	9
Bozeman	...	...	1	...	...	...	...	...	...	...	...	1	1	1	...	...	4	8
Butte	...	7	2	2	...	3	...	2	7	1	3	4	2	4	...	1	21	59
Great Falls	...	...	2	...	...	1	...	...	1	1	1	...	1	4	1	...	8	20
Helena	...	4	...	...	...	...	...	...	2	...	3	...	3	1	3	...	10	26
Livingston	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2	2
Missoula	...	2	...	...	...	6	...	...	4	1	...	...	...	1	...	...	6	20

TABLE II.—(Continued.)
NOVEMBER, 1908.

	Smallpox	Tuberculosis	Diphtheria	Scarlet Fever	Measles	Typhoid Fever	Whooping Cough	Meningitis	Pneumonia	Nephritis	Organic Heart Disease	Malignant Tumors	Acute Intestinal Diseases	Violence	Suicide	Alcoholism	All Other Causes	Totals	Annual Total
Beaverhead	...	...	...	...	...	...	...	1	1	...	1	...	1	2	...	...	1	7	65
Broadwater	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	1	2	41
Carbon	...	...	1	...	...	1	...	...	2	...	...	...	...	11	...	...	2	17	149
Cascade	...	3	1	1	...	3	...	1	2	...	1	...	...	2	...	1	6	21	310
Chouteau	...	...	...	...	...	1	...	...	1	...	...	...	1	1	...	...	...	4	88
Custer	...	...	2	...	...	...	...	...	...	1	...	...	1	1	...	...	2	7	89
Dawson	...	...	...	...	...	...	...	...	...	1	1	...	...	...	...	...	1	3	60
Deer Lodge	...	...	1	1	...	2	...	...	4	...	2	...	...	1	...	...	9	20	243
Fergus	...	...	...	...	1	...	...	...	...	...	...	...	...	1	...	...	2	4	104
Flathead	...	1	2	...	...	1	...	...	1	1	2	1	2	4	...	1	5	21	233
Gallatin	1	...	...	1	...	...	...	...	1	1	...	1	...	1	...	...	1	7	128
Granite	...	...	...	...	...	...	...	...	...	1	...	...	...	1	1	...	1	4	38
Jefferson	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	2	3	68
Lewis & Clk	...	2	2	2	...	...	...	...	1	2	1	1	3	3	1	1	8	27	286
Madison	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	2	3	94
Meagher	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	32
Missoula	...	1	2	1	...	5	...	...	5	1	2	1	...	9	...	2	5	34	424
Park	...	...	...	1	...	...	...	...	...	1	2	...	...	...	...	...	4	8	118
Powell	...	...	...	...	...	...	...	...	1	1	...	...	1	3	...	...	...	6	77
Ravalli	...	1	...	...	...	1	...	...	...	...	...	1	...	1	...	...	1	5	111
Rosebud	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	1	2	27
Sanders	...	...	...	...	...	...	...	...	...	...	...	...	...	2	...	...	...	2	54
Silver Bow	...	16	1	1	...	1	...	...	4	6	9	5	2	10	2	2	22	81	898
Sweetgrass	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	24
Teton	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	1	...	2	14
Valley	...	...	...	...	...	1	...	...	...	1	...	...	...	1	...	...	1	4	73
Yellowstone	...	1	...	...	...	1	...	...	2	1	...	1	...	5	...	1	3	15	253
Totals	1	25	13	8	1	17	...	2	26	18	23	11	11	60	4	9	80	309	
Annual Total	1	315	149	80	17	128	13	92	453	185	300	139	185	613	81	101	1249	...	4101

Annual death rate per thousand population, 14.06.

DEATHS FROM PRINCIPAL CAUSES IN CITIES OF 5,000 OR MORE INHABITANTS.

Anaconda	...	...	1	1	...	...	...	...	3	...	2	...	...	1	...	...	4	12	159
Billings	...	1	...	...	...	1	...	...	2	1	...	...	...	2	...	1	3	11	157
Bozeman	1	...	...	1	...	...	...	...	1	1	...	...	...	...	...	...	...	4	64
Butte	...	14	1	1	...	...	...	...	3	4	9	5	2	6	1	...	18	64	592
Great Falls	...	3	...	1	...	3	...	1	2	...	1	...	...	1	...	...	5	17	243
Helena	...	2	1	2	...	...	...	...	1	2	1	...	3	2	...	1	7	22	222
Livingston	...	...	...	1	...	...	...	...	...	...	1	...	...	...	...	...	1	3	69
Missoula	...	1	2	1	...	5	...	...	5	...	2	1	...	4	...	2	3	26	228

TABLE III.

Showing Births by Counties, Sex, and Nationality of Parents.

COUNTY.	Male	Female	Total	Both American	Both Foreign	American Mother	American Father	Not Stated
Beaverhead	47	41	88	57	14	15	2	....
Broadwater	39	25	64	41	4	16	3	....
Carbon	155	148	303	123	139	28	11	2
Cascade	307	306	613	305	182	65	44	17
Chouteau	84	62	146	91	26	11	18	....
Custer	63	76	139	102	15	11	9	2
Dawson	63	54	117	82	21	9	5	....
Deer Lodge	136	108	244	76	124	23	21	....
Fergus	77	93	170	122	22	15	10	1
Flathead	196	162	358	227	64	34	31	2
Gallatin	117	128	245	187	35	14	8	1
Granite	25	18	43	15	16	7	3	2
Jefferson	47	45	92	50	19	14	6	3
Lewis and Clark	160	161	321	175	69	42	33	2
Madison	60	71	131	96	20	6	7	2
Meagher	24	17	41	29	6	5	1	....
Missoula	161	186	347	220	70	37	17	3
Park	150	135	285	195	59	23	8	....
Powell	27	22	49	36	6	6	1	....
Ravalli	99	123	222	173	23	20	4	2
Rosebud	36	30	66	46	6	9	5	....
Sanders	21	12	33	28	2	1	2	....
Silver Bow	595	490	1085	396	489	123	76	1
Sweetgrass	34	25	59	44	8	4	2	1
Teton	27	24	51	25	7	7	6	6
Valley	73	64	137	80	39	10	6	2
Yellowstone	192	201	393	278	59	35	19	2
Totals	3015	2827	5842	3299	1544	590	376	51

Investigation of the Cause and Means of Prevention of Rocky Mountain Spotted Fever Carried on During 1907 and 1908, by

DR. H. T. RICKETTS

of the University of Chicago.

ROCKY MOUNTAIN SPOTTED (TICK) FEVER.

The Legislature of 1907 appropriated $2,000 to defray the expenses incurred in the study of Spotted Fever in the Bitter Root Valley, provided that this study be conducted by Dr. H. T. Ricketts under the supervision of the State Board of Health, and further provided that Dr. Ricketts mak a report to the Legislature, through the State Board of Health, setting forth the results of such study.

In order that the legislators and the people of Montana may thoroughly understand that this work is being done by Dr. Ricketts absolutely without compensation from Montana, let it be understood that not one cent of this appropriation was paid Dr. Ricketts for services rendered, but every cent was paid out for expenses, these expenses being verified and accompanied by receipts from the person to whom the money was paid. These receipts are on file with the clerk of the State Board of Examiners.

The appropriation made by the State was for one year only, hence it was necessary that money be provided or the work discontinued during the year of 1908. Therefore the secretary of the State Board of Health appealed to the two counties most affected by this disease (Missoula and Ravalli counties) and the county commissioners of the counties appropriated $1,150 to assist in defraying the expenses incurred in continuing the study of this disease. This was reported to the State Board of Health and the board determined to expend $500 of the appropriation made for said board to complete the amount necessary to defray the necessary expense for continuing the work.

In talking to the comissioners of Missoula county the secretary was confronted with the following: "The expenses incurred in studying this disease should be met by the State, that the people of the counties affected are assessed to defray the expenses incurred in studying diseases among cattle and sheep and that the portions of the State where stock raising is the principle industry should help in paying the expenses necessary to study a disease among the people where stock raising is a minor industry." The State Board of Health has repeatedly advanced this argument in favor of appropriation for the study and prevention of diseases among the people of the State.

As a result of the study made by Dr. Ricketts it has been absolutely proven that the tick transmits the disease to man and

the virus is kept alive by transmission from the tick to some of the lower animals of the valley. Other results of this work are set forth in the reports of Dr. Ricketts, which follow:

As a result of this work we are in possession of the necessary information for fighting this disease. The fight must be directed against the tick. This does not mean that it is necessary to destroy all the ticks in the infected districts, but it is possible to so reduce the number of ticks as to practically, if not quite, destroy the infection. The means by which this may be accomplished are also set forth in Dr. Ricketts reports.

It has been said that the people do not see the results of this work. The people are looking for results in the wrong direction. The study of yellow fever proved that the mosquito was the means of transmission to man, but this study did not check the disease; it was necessary that the results of study be made use of and the mosquito eradicated in infected districts, or reduced to a minimum. So it is with Rocky Mountain Spotted Fever, the study of Dr. Ricketts, or all the scientists in the world, will not stop the disease unless the information furnished by them is made use of by the people. As a result of the study to date we know that the tick is the means by which this disease is transmitted to man, and we know how the tick may be eradicated, or so reduced in numbers in the infected district as to remove practically all danger from infection. This work will never be successfully accomplished by local work. It is necessary that positive laws be enacted to secure the necessary measures and that money be provided for the enforcement of such laws.

That the people of this State may understand the character of the work being done by Dr. Ricketts (and it must at all times be remembered that Dr. Ricketts does not receive one cent from this State beyond the amount necessary to pay his actual expenses while engaged in the study of this disease) they should know that at the last meeting of the American Medical association Dr. Ricketts was awarded the grand prize for original research, and his work consisted in a demonstration of what he had discovered in the study of this disease in Montana.

You will find that Dr. Ricketts speaks of the danger of this disease extending to other parts of the state. "Old timers" will "hoot" at this idea. But do not be too quick to draw conclusions. Take the conditions in Idaho and see to what an extent the disease has extended there during the last few years. The

disease has at times appeared in Carbon county and it is necessary that conditions be studied in order that the facts may be known as to whether they are favorable for extensions to other parts of this State.

It is essential that the study of this disease be continued and that ways and means be provided to prevent infection at present, the information we possess being sufficient to justify radical efforts at reducing the number of ticks in the infected districts. I wrote to Dr. Ricketts and asked him to give me a statement of the indication for the continuation of the scientific study, the cost of such investigation and the indication for measures tending towards the prevention of the disease with our present information. His reply is as follows:

(1). a. INDICATIONS FOR CONTINUING SCIENTIFIC INVESTIGATION.

Montana has attracted the favorable attention of the whole scientific world by the vigor and foresight with which it has attacked a disease which causes a high mortality among its inhabitants in a certain section of the State, and which has within itself the possibility of extending to other parts of the commonwealth.

The main practical points which have so far been discovered are the following: The wood-tick is the means by which man is infected. Some of the native small animals are susceptible to spotted fever. The disease is kept alive from year to year by alternating between the tick and one or more of the native animals, the identity of which has not yet been determined positively. Two means, both of which are practicable, have developed which, when put into practice, will decrease the prevalence of the ticks and of the disease (see under "2"). A serum has been discovered which promises to be a good protective and which may have good curative powers if its strength can be increased. (This is now being studied). Discoveries have been made which give reason to believe that an efficient method of vaccination is possible as an additional method of preventing the disease among those who would not be protected by other means, i. e., among those who by virtue of their occupation must necessarily go back into the hills in infected regions, where general means of prevention could not well extend.

The main points which yet remain to be investigated or which require further investigation are the following: The com-

pletion of the study of the susceptibility of the local animals to spotted fever. The study has been practically completed with four or five different animals, but as many more remain to be studied. This study will disclose which animals, in co-operation with the tick, are essential to keep spotted fever alive in the State, and has its practical application in this fact, that a campaign against the disease will be greatly aided by the destruction of the susceptible animals. This involves also the discovery of the animals which actually suffer from spotted fever in nature. The discovery of the animals which are susceptible to experimental inoculation and to experimental infection with the tick, necessarily precedes the search for those which actually suffer from the disease in nature. This is the longest, most difficult and most expensive phase of the work, and is also the most important yet to be worked out. The results have been very successful insofar as they have been completed, the methods of working have been proved to be correct, and there is every reason to believe that the final result will be positive and satisfactory.

"2. The identification and cultivation of the germ which causes the disease. The germ has never been positively identified and has never been cultivated under artificial conditions. The identification of the germ micrscopically is important for many reasons. Two practical reasons may be mentioned: It would make the diagnosis of the disease in the patient possible at an early date in his infection, so that proper treatment could be begun earlier than is possible at present; it would decrease the cost of investigation enormously, since at present the only means of determining the presence of the germ is by means of animal inoculation, and the animals cost a great deal when used in the large numbers which the work requires. No assurance can be given that the germ will be discovered; it has already been attempted many times with negative results, and the same is true of a good many other infectious diseases. All the means of search have not been exhausted however and the germ may yet be discovered.

Cultivation of the germ in artificial medium is desirable from the practical standpoint chiefly because it may then be possible to obtain a curative serum of sufficient strength to control the disease satisfactorily. Unless this can be done it may never be possible to obtain a strong serum. It would also be of the greatest help in the preparation of a satisfactory vaccine against

the disease. This problem is now being studied in the laboratories of the University of Chicago.

3. A closer study of the distribution of infected ticks in the Bitter Rot Valley, and investigation of the occurrence or nonoccurrence of infected ticks in parts where the disease does not occur. This bears on the posible extension of spotted fever.

4. The distribution throughout the State of the ticks which are capable of contracting spotted fever.

5. The study of other ticks which are found in the Bitter Root Valley and elsewhere in the State ,to determine whether or not there is more than one species of tick which is able to carry spotted fever.

6. The study of what is called the host relationship of the ticks which are able to carry spotted fever, by which is meant the relationship of the ticks in their different stages to the animals which are susceptible to spotted fever.

7. Further studies of the relationship of the germ of spotted fever to the ticks while in the body of the ticks, and the condition in which the virus is transmitted in a hereditary manner from one generation of ticks to the next. It is important to discover the exact conditions under which the disease is kept alive from one year to the next. It has already been found that the disease is hereditary in the tick, but there are irregularities, the cause of which it is important to discover.

This may not be a complete outline of the work yet to be accomplished, but they are the important points which are apparent at present. Further points may come to light as the work progresses.

(2). INDICATIONS FOR LAWS PROVIDING FOR PREVENTIVE MEASURES, ESPECIALLY OILING DOMESTIC ANIMALS AND PROVIDING QUARANTINE FOR UNOILED ANIMALS.

Massive numbers of ticks feed on the domestic animals (horse, cows and to some extent dogs), the females mature on them and after dropping off lay their eggs, and are thus responsible for large numbers of ticks during the following spring. It is the uniform belief in the Bitter Root Valley that the number of ticks in the vicinity of the ranches, i. e., in close proximity to man, has increased greatly since the valley has been more thoroughly settled and the number of domestic animals has increased.

It is manifest, therefore, that if the tick could be prevented from feeding and maturing on the domestic animals, that the number of ticks would be greatly decreased, and that the more thoroughly this was done the greater would be the decrease. This has been abundantly proved in the South, in the fight against the tick fever (Texas fever) of cattle. This can never be done in the Bitter Root Valley unless there is some organized effort, and there is the best reason to believe that this organiedz effort will not come into existence, except through the enactment of State laws, which require the oiling of the stock and dogs in infected districts during the seasons when the ticks mature on the animals, i. e., during the months of spring from about the middle of March until the first or middle of June. This cannot be left to the discretion of ranchers, as many will not comply, or they will be irregular in their efforts.

In order to make such a regulation effective the proper authorities should have the power of declaring quarantine against the animals of any individual in the district named, when it is found that he is not carrying out the provisions in regard to oiling. Such a quarantine would necessitate that all his stock be kept strictly within the limits of his own premises, which would prevent them from scattering ticks in or near the premises of others. The quarantine power naturally should cover the period only during which the oiling is required.

It may be argued against the effectiveness of the method of oiling that many other animals aside from the domesticated stock are fed on by the ticks, and that it would be useless to oil the stock so long as this is the case. This, however, is not a good argument against the practice of oiling for the following reasons: In the first place the larger wild animals which are fed on by ticks do not often come in close proximity to man and deposit ticks in his vicinity. Then the fact that ticks also feed on the small wild animals is no argument against destroying the ticks so far as is possible. If the ticks are kept from breeding on larger domestic animals it will greatly decrease the number which can feed on the small wild animals. There is good reason to believe that a large proportion of the ticks which feed on the small animals come from those which have previously fed on the larger animals, although without question ticks are capable of existing on the small wild animals independently. The probable effectiveness of decreasing the num-

ber of ticks by preventing their feeding on the large animals may be best understood when we consider that a certain proportion exists between the number of ticks in the valley and the number of cases of spotted fever which occur. If the number of ticks can be decreased one-half the number of cases of spotted fever would decrease one-half. If they could be decreased tenfold, there would be one case of spotted fever where we now have ten. It is important to understand that it is not necessary to absolutely exterminate the species of tick in order to get spotted fever under conrol. The situation is exactly like that in relation to yellow fever, where it is found that by keeping the number of mosquitoes down to a certain point it is possible to prevent the development of the disease; it is not necessary to absolutely exterminate the yellow fever mosquito.

The question should also be considered of killing off, as far as possible, the small wild animals which are susceptible to spotted fever and which also are fed on by the ticks. This, so far as the question has been studied, has reference to the gopher or ground squirrel and the rock squirrel above all others, since they seen to be fed on by the ticks more than the others, but it applies also to the wood-chuck, the chipmonk and mountain rat. Other species remain to be studied. The destruction of these animals not only decrease the number of animals which are susceptible to spotted fever, but since they are utilized as hosts by the ticks it would still further tend to reduce the number of ticks.

Another procedure involved in the destruction of the tick is the clearing off of the land in infected districts. Burning off or otherwise getting rid of the brush and small trees, perhaps large ones, too, which favor the life of the tick, by affording them shade and moisture, and also by affording a residence for certain small wild animals on which the ticks thrive. I do not know just how this could be gotten at, but perhaps the State Board of Health should be given special powers in the matter, say the owners should be given until a certain time to clear off their land, and if it is not done within that time, it will be done by the State at the owners expense. It is a good thing to remember that the battle against plague in San Francisco cost $1,100 a day for quite a long time.

3. THE DANGER OF THIS DISEASE EXTENDING TO OTHER PARTS OF THE STATE.

When spotted fever once reaches a district two factors are necessary to keep it alive. First, the presence of the proper tick, and, second, the presence of the susceptible animals. The distribution of the Montana spotted fever tick through all parts of the State is not yet known. It is known to exist, however, on the east side of the Bitter Root Valley, where there is said to be no spotted fever, in the Valley of Rock Creek, and in districts north of the Bitter Root valley. In all probability it is widely distributed in the State. Ticks taken from the vicinity of Helena and from near Bridger resemble the spotted fever tick of the Bitter Root Valley; their positive identification by a specialist is yet to be made.

The small wild animals which are susceptible to spotted fever are widely distributed in Montana.

That spotted fever is capable of extension is illustrated by two cases in the Bitter Root Valley which occurred in localities where spotted fever had not occurred hitherto. One of these cases occurred in 1906 on Hayes Creek, north of LoLo Valley, while prior to that time it had never occurred north of Lo Lo Valley. Another occurred on the east side of the Bitter Root Valley only last spring. It is also to be remembered that cases of spotted fever formerly occurred on Rock Creek when it was inhabited more than at present, and that occasional cases occur in the vicinity of Bridger.

The conditions in Idaho also illustrate that the disease is capable of extending itself into new territories. Whereas some years ago none was known on the south side of the Snake River, many cases occur there annually now. It has extended to such an extent in Idaho that 375 cases occurred there during the last spring. The increase of the disease in Idaho probably is due to some extent to the increase in population in infected localities, although it has extended geographically as stated.

THE APPROXIMATE COST OF SCIENTIFIC WORK WHICH SHOULD YET BE DONE.

The estimate is based on the following considerations:

Two more seasons of work in the field, the seasons consisting of about six months each; two more seasons of winter work in my laboratory in Chicago; assistance required in the field work, and in laboratory work; the cost of animals and supplies,

and feed for animals, which in the winter is a large item; traveling and other expenses; transportation of animals and supplies and incidentals.

A season's work in the field requires approximately $2,000, and a season of laboratory work in Chicago about $1,000. Hence I estimate that the work remaining to be done should be supported by an appropriation of not less than $6,000 for actual expenses.

This estimate does not include a survey of the ticks of the State, nor of the distribution of the animals which are susceptible to spotted fever throughout the State. It does include, however, the cost of a tick survey of the Bitter Root Valley, and the relation of all ticks found to spotted fever. It also includes a thorough study of the susceptibility of all animals in the Bitter Root Valley which are fed on by the ticks. If the distribution of the spotted fever tick, and of susceptible animals throughout the State, is to be investigated, a sum not less than $2,000 should be added to the estimate of $6,000 given above."

These are the indications for continuing the investigation of this disease, the estimate of cost of such work, and the indications for enacting laws to fight the cause of this disease, as given by a scientific individual who devoted one season to the work in this State at his own expense and who has given this State the benefit of two additional years' work for which simply his actual and necessary expenses have been paid. Dr. Ricketts does not suggest that he continue the work. He does not say that he is willing to do so, but the tone of his communication seems to indicate that he is willing to continue the study of this disease. He has received no remuneration from Montana and has not asked any, nor does he ask for remuneration now.

What is the character of his work? Simply the character of work that secures the highest reward in the gift of the medical profession of America, the first prize for original research. If the people of Montana want this work continued do not place him in the position of having to practically (or have some one do it for him) beg the county commissioners to pay his actual and necessaray expenses.

SPOTTED FEVER REPORT

NO: 1.

General Report of an Investigation of Rocky Mountain Spotted Fever, carried on during 1906 and 1907

BY

H. T. RICKETTS, M. D.

LETTER OF TRANSMITTAL.

Dr. Thomas D. Tuttle,
Secretary of the Montana State Board of Health.
Helena, Montana.

Dear Sir:

I have the honor to submit herewith a "General Report" of the investigation of Rocky Mountain Spotted Fever, which I have conducted since the spring of 1906, this report being in compliance with the terms of a bill passed by the Legislative Assembly of 1907, by which certain money was appropriated for the support of the work.

That the investigation has been attended with a good measure of success will, I believe, be apparent from the report. The most noteworthy result is contained in the proof that the wood-tick (Dermacentor occidentalis) is the means of infecting man with the disease. It is possible that this conclusion will not be a popular one in the Bitter Root Valley, but every one will admit the necessity of finding out the exact facts in the case so that an intelligent and correct course can be planned in combatting the infection. With the proof that the tick is the transmitter, at least one remedial or preventive course is clearly indicated, and this consists of methods for the eradication of the ticks in proximity to man, according to the principles outlined in this report.

It is manifest that such a campaign cannot be carried on successfully without the understanding and the co-operation of those who are most concerned, namely, the residents of the Bitter Root Valley. In preparing this report I have had it in mind that the residents will need and, I believe, appreciate instruction bearing on the nature of the disease, the habits and life cycle of the tick, and those features of the tick which explain some of the peculiarities of spotted fever, such as its geographic distribution and its limitation to the spring. I have also gone into some detail regarding the principles of eradication of the tick, in order that they might better understand the methods which it is necessary to employ. They should appreciate that the eradication of the tick to such an extent that it will decrease the prevalence of spotted fever, is not a hopeless task; that it

is not necessary that the tick be absolutely eradicated from the hills in order to accomplish this purpose, but rather that it be eradicated from their immediate premises and from vicinities which they frequent. It is of equal importance that they should prevent such infestation of their premises as occurs when tick-laden animals are brought in from the hills.

With these points made clear it seems that their co-operation should be obtained in the work of eradication.

The investigation is by no means complete with the work herewith reported. It may be that future work will produce some specific means of prevention, and this subject is being prosecuted now. Many problems remain to be taken up in the field, such as a more complete study of the life history of the tick, its host relationships, the susceptibility of various local animals, etc. The study of these problems, and many more which might be enumerated, is esential to the thorough knowledge of the disease requisite for its control. It is hoped that the State of Montana will see its way clear to provide means for the completion of the work.

I wish to acknowledge the uniform co-operation and courtesy extended by yourself and other members of the Board of Health, and other State officials with whom I have come in contact during the investigation. It is particularly gratifying that the attitude of your board toward the scientific aspects of the work has been such that you have patiently awaited the results of inquiries which, on first thought, might seem rather remote from the main problem, but which, in their ultimate results, are of distinct practical importance.

The citizens and the physicians of the Bitter Root Valley have encouraged the work to the full extent of their power. I am especially indebted to Dr. E. W. Spottswood, surgeon-in-chief of the Northern Pacific Hospital, and to Dr. Geo. E. Dix, assistant surgeon, for the courtesies of the hospital and its laboratory; to Prof. M. J. Elrod, for the use of his laboratory and apparatus; to Dr. Edgar F. Dodds for assistance on various occasions, and to the management of St. Patrick's Hospital for certain privileges.

The Northern Express Company gave financial assistance by carrying animals and supplies free of charge.

Special thanks are due to Mr. P. G. Heinemann for detailed bacteriologic studies carried on in the summer of 1907, in the

field, and which are still being prosecuted in Chicago, and to Dr. M. B. Mayer for assistance in experiments with the tick carried on at the University of Chicago. Mr. J. J. Moore was of great value in conducting experiments with the tick in the field in the summer of 1907. Dr. E. R. LeCount is engaged on a study of the pathology of the disease; Mr. L. Gomez is assisting in a study of the questions of immuntiy, vaccination and serum therapy, and Dr. S. A. Matthews, with the writer, has undertaken to determine the effect of various drugs on the disease. A report of these phases must be deferred until work now in hand is completed.

The University of Chicago has aided the work in every way possible, granting me time away from routine duties and bearing a portion of the expenses of the work.

The Memorial Institute for Infectious Diseases, Dr. Ludvig Hektoen, director, Chicago, tided over a period of financial stringency, when other funds were exhausted.

The financial assistance rendered by Ravalli and Missoula Counties has been greatly appreciated.

I shall at a future date render you a detailed account of the experiments on which this report is based.

Respectfully Yours,

H. T. RICKETTS.

Chicago, January 15, 1908.

CONCERNING THE NAME OF THE DISEASE.

In order to avoid confusion, I have used the rather awkward term of "Rocky Mountain Spotted Fever" when writing for publication concerning this disease. In what follows I shall refer to it briefly as "spotted fever."

Some confusion has arisen because two other diseases of man bear the same popular name, i. e., epidemic cerebro-spinal meningitis, and typhus or ship fever. The term "human tick fever" has also been used in speaking of the disease, but it is open to the same objection as "spotted fever," since there exists another human tick fever in Africa which is different from the Rocky Mountain Tick or Spotted Fever.

The proper name for the disease can be devised only after the specific micro-organism has been discovered and identified. This was the principle followed by Wilson and Chowning when they called it Piroplasmosis hominis. However, their belief that the disease is caused by a prioplasma has not been sufficiently corroborated, hence it does not seem justifiable to use this name at present.

CONCERNING THE GEOGRAPHIC DISTRIBUTION OF SPOTTED FEVER.

Spotted fever is not limited to the Bitter Root Valley nor to Montana. It occurs in a number of adjacent states to such an extent that it may be considered as a disease at least of the northern and middle Rocky Mountain states. There is indeed no accurate knowledge of its limitations at this time. Judging from a few articles which have been published during the last few years, and from information obtained privately, it is evident that the disease has been recognized in a good many localities, concerning which the general public and the general medical profession have no information. That it occurs along the Snake River and some of its tributaries in Southern Idaho, and in certain sections of Oregon, Utah, Colorado, Wyoming and Nevada, is quite certain.

There are many reasons for believing that the disease, as it occurs in these different states, represents a uniform process in spite of great variations in the mortality. Apparently it is much more virulent in the Bitter Root Valley than elsewhere, a phase of the subject which requires investigation.

The question, therefore, is not only a local one, but one of interstate importance, and in view of the method of transmis-

sion, i. e., by the bite of the wood-tick, we may yet have to answer the question as to whether an extension of the disease beyond its present limits may reasonably be expected in the course of time.

PREVIOUS SCIENTIFIC STUDIES.

The scientific study of spotted fever has been limited largely to the Bitter Root Valley, although notes, principally clinical, have been published by physicians in other localities.

Wilson and Chowning carried on their investigation during 1902 and 1903, and came to the conclusion that man is infected through the bite of the wood-tick, and that the special cause of the disease is a minute protozoon organism Piraplasma hominis. They were inclined to believe that the gopher is the natural host for the micro-organism, and that man is infected by ticks which had previously fed on infected gophers. Their reasons for assigning to the tick the role of carrier are that the disease is limited to that season of the year in which the adult tick is active and when it is known to feed extensively on man; and second, that the history of a recent tick-bite is obtainable in nearly every case of spotted fever, and in the event that such a history is not given the possibility of a recent tick-bite cannot be definitely excluded. The hypothesis, that the gopher plays a part in the maintenance of the disease rested on the finding of the microbe, Piroplasma hominis, in the blood of a considerable number of gophers from the infected side of the valley, whereas it was absent from those of the uninfected side.

In 1903 Dr. John A. Anderson, of the Public Health and Marine Hospital Service, agreed with Wilson and Chowning concerning the role played by the tick and the nature of the microbe which causes the disease. On the other hand Charles W. Stiles, of the same government service, stated that he was unable to accept the tick theory, denying also the presence of the microbe, Piroplasma hominis.

From these conflicting reports it is evidence that the whole subject was in a state of confusion, as a result of the report of Stiles, and that our knowledge of the disease was no more satisfactory than before.

PERSONAL INVESTIGATIONS.

Some Facts Concerning the Nature of Spotted Fever.

Casual observation suggests that spotted fever is caused either by a very poisonous chemical substance, or by virulent

micro-organisms. Theoretically it would be impossible to distinguish between the two without experimental studies, although to one who is familiar with the general aspects of chemical poisonings and of microbic diseases, spotted fever would appear to fall among the latter much rather than the former.

It has been possible to decide this point definitely, however, and the first step in the proof was made in the spring of 1906, when I showed that spotted fever can be transferred, to the guinea pig and the monkey, by injecting into them small quantities of blood taken from the patients who are sick with the disease. Not only can this be done, but the infection can be kept alive indefinitely in these animals by transferring blood from sick to healthy animals.

It should be stated that spotted fever in the guinea-pig and monkey is a very characteristic disease, and that it can be recognized in them almost as easily as in man. The fever and the eruption are the same, and when the animals die the changes in the organs resemble very closely those seen in man.

Thse results show two very important facts relating to the character of the disease. First, that spotted fever is caused by a microbe, a living organism, rather than by a non-living chemical substance. This is proved by the fact that the disease can be passed indefinitely from guinea-pig to guinea-pig or from monkey to guinea-pig, by the injection of diseased blood. One "strain" of the virus has been kept alive in this way since the spring of 1906. If the cause of the disease were some non-living chemical poison it could not have been passed through more than two or three generations of animals at the most liberal estimate. Only those diseases which are caused by living organisms can be perpetuated in this way. In this case it is not necessaray to see the microbe in order to prove that spotted fever is a germ disease.

The second important point brought out by these experiments is that spotted fever is an infection in which the organisms are distributed throughout the whole body. This must be true if the blood is infective, for blood infection means generalized infection. This has been further supported by inoculation experiments which show that the virus or microbe is present in the brain and spinal cord, liver, spleen, kidney and, in fact, in all the organs of the body. It is necessary to inject only one-fourth to one-third of a drop of diseased blood in order to produce spotted fever in the guinea-pig.

The attempt to recognize the parasite described by Wilson and Chowning has met with failure so far, and exhaustive search on my part and on the part of others who volunteered to assist, has not yet resulted in the positive identification of any other microbe.

The germ may be too small to be seen with our high power microscopes, as appears to be the case with measles, scarlet fever and a number of other infectious diseases. Or, possibly, it refuses to take up the dyes which are commonly used to render micro-organisms visible. The possibility or impossibility of forcing germs through filters of different grades of porosity is sometimes taken to indicate roughly the size of the germ. Inasmuch as the micro-organism of spotted fever cannot be passed through even course filters (Berkfeldt), there is some reason for believing it will be recognized eventually.

THE MEANS OF TRANSMISSION.

From all that is known of spotted fever, we may conclude that it is not transmitted from man to man in any such way as scarlet fever, measles or diphtheria are transmitted. It is not a contagious disease. It is well known in the Bitter Root Valley that there is no particular danger involved in caring for a patient who has spotted fever, and that more than one case in a given family at the same time or even during the same season is a rarity. Likewise, observations on many hundreds of animals which have been inoculated with spotted fever and have been kept with healthy animals, show conclusively that the disease is not a contagious one.

In taking up the question of transmission, I shall first consider somewhat briefly theories which, in the past, have had more or less acceptance in the valley. This is no more than just to those who have conscientiously supported such theories in the past.

Probably the theory most often expressed is that the disease is acquired by drinking from streams and ditches which drain foci or decaying vegetation which lie in ravines and low places in the mountains and foot-hills. Inasmuch as this theory presupposes that the virus enters the body from the digestive tract, it has been very easy to perform experiments on guinea-pigs to determine whether or not infection can take place in this way. The best technic for such experiments is to introduce the virus, in the form of diseased blood, directly into the stomach

of the guineau-pig by means of a stomach tube. It has not been possible to produce spotted fever in the guinea-pig in this way, and the result argues very strongly against the possibility of man acquiring the disease through drinking water.

Furthermore, there are other considerations of a more general nature which render the water theory improbable. The sharp limitation of the disease to the mouths of springs is more or less against it, although it is claimed by some that the water theory explains this peculiarity of the disease as well as the tick theory does. It is argued that the spotted fever season opens as soon as the snow begins to melt in sufficient quantities to flush out the low places in the hills and cause a rise in the streams; and also that the fever season closes when most of the snow has melted and the streams have begun to go down. This is true for most seasons, and is the one fact which in the past has rendered the water theory fairly plausible. It does not hold true, however, for the season of 1907; during the winter of 1906-1907, the snowfall was unusually heavy and the spring was colder than is customary. Hence, melting of the snow in large quantities, and high water in the streams, continued for some weeks after the spotted fever season was past. On the other hand, the fact that the spotted fever is limited to the spring goes as well with the tick theory as it does with the water theory, and there is so much other evidence in favor of the tick theory, that the argument, as applied to the water theory, loses its force very largely.

The distribution of spotted fever and the isolation of individual cases is not in harmony with the theory of water infection. Epidemics of cholera and typhoid fever are often caused by the use of infected water—the so-called "water-borne" epidemics. In such cases the disease breaks out suddenly and all at once strikes a considerable percentage of the people who have used the infected water. We should expect this to be true with respect to spotted fever if it is caused by infected water, but such is not the case. There are too few cases at any one time along the banks of a given stream.

Furthermore, in the transmission of an infectious disease to man by means of water it is often possible to trace the disease to a previous patient who lived a little farther up the stream. There appears to be no such connection between cases of spotted fever.

The possibility of spotted fever being conveyed directly to man from some animal may also be mentioned here, since this does occur in connection with some diseases, particularly tuberculosis, and a recently discovered disease, paratyphoid fever. In these instances, however, man becomes infected through his digesctive tract after eating the meat or drinking the milk from diseased animals; and as stated above, experiments have shown that it is difficult or impossible to cause spotted fever in a susceptible animal by feeding him infected material. The same objection holds, if one assumes that the streams may become infected with the excretions (urine or feces) of animals suffering from sypotted fever, or from the carcasses of animals which have died of the disease.

Naturally, also, the assumption that one may contract spotted fever by eating the meat or drinking the milk of sick animals presupposes that there are susceptible animals among those which are utilized as food. I have not completed my investigation of this subject. The results obtained so far indicate that the young calf is not susceptible, and that the sheep and goat possess at the most a very slight susceptibility. A short course of fever can be produced in the horse by the injection of large quantities of infected blood (the horse is certainly not used as meat in the western states). Chickens and pigeons appear not to be susceptible at all. Hence these investigations in so far as they have now been completed indicate that there is little chance of man acquiring spotted fever from animals which are used as food, chiefly the cow (or ox) and fowl.

Of the wild animals which I have tested, the gopher seems to be the most susceptible, and even this susceptibility is very irregular and not greatly developed. Rats and mice cannot be infected by inoculation. In the spring of 1906 domesticated rabbits could not be infected by the injection of blood from human patients. Recently, however, this variety of rabbit has shown susceptibility. The exact cause of this discrepancy remains to be determined. Since the virus, which is used for the experimental work, has resided in the guinea-pig for many months, it may have acquired virulence for the rabbit on this account, a phenomenon which has many analogies in microbic diseases. It is also possible that, in the original experiments, the human blood which was used for the inoculation of the rabbits was taken so late in the disease that it had lost the

power of infecting the rabbits. In the animal experiments the inoculations often have failed to "take," if the transfer was made late in the course of the fever.

The fact that the domesticated rabbit is susceptible does not prove that the varieties of wild rabbits which are native to the Bitter Root Valley are also susceptible. It is possible that they too are susceptible, but the question must be decided by actual experiments. The part which the gopher and possibly the rabbit may play in the maintenance of the disease will be referred to later.

It is a remarkable feature of spotted fever that it appears in "crops" when a few warm days have followed a "cold spell." It is thought by some that this supports the water theory inasmuch as a few warm days cause the melting of a good deal of snow and the flushing out of the low places with a considerable rise in the streams. Also if a second "cold snap" follows a few warm days, the development of new cases would seem to be stopped by the cold weather. This stops the flushing out of the foci or decaying vegetation, and, according to the water theory, decreases the amount of water carried into the streams, and consequently causes a check in the development of new cases of spotted fever. Although one must recognize the plausibility of this reasoning, it must be appreciated that the alternating of cold and warm weather also exercises a great influence on the activity of the tick. During cold weather the ticks which are not already attached to the warm skin of an animal, lie dormant in nature, and during this time, one collects few ticks on his clothing when in the woods. On the other hand, if one goes into the woods on warm sunny days in the spring he may return with many ticks in his clothing. Such occurreces have been related to me many times, and such has been my own experience. Hence the appearance of spotted fever in "crops" when a warm spell follows a cold spell supports the tick theory as much as it does the water theory.

I may refer briefly to another hypothesis which has been advanced by a number of persons to the effect that spotted fever may be derived from noxious vapors which arise from decaying vegetation, at the onset of warm weather in the spring. I have not taken this hypothesis seriously because modern investigations have shattered the old theories in regard to the so-called "infectious miasms," which were supposed to arise from stagnant

water and decaying vegetation. There is no known example of an infectious disease being transmitted from such sources in this way. It is true that this was an old theory in regard to malaria, but recent scientific work has shown that malaria can be transmitted only by the bite of a particular mosquito.

Of the theories which have been discussed, only the water theory is sufficiently plausible on first thought to render it worthy of serious consideration, and I have discarded it only because a careful weighing of the evidence, and the results of experimental work render it untenable.

The question arises as to whether spotted fever can be transmitted through abraisions in the skin. There is no reason to believe that this ever ocurs naturally, but it seemed best to work it out experimentally. When the skin of the guinea-pig has been shaved roughtly so as to leave many small abrasions, it will not contract spotted fever when the virus (infected blood) is smeared over the surface of the abraded skin. However, if two or three incisions are made through the thickness of the skin and the virus is then rubbed in, the animal may contract the disease. This method really amounts to a cutaneous or subcutaneous injection of the virus, and the result could well be anticipated, since subcutaneous inoculation of the virus invarably produces spotted fever.

Inasmuch as these experiments show that infection does not take place readily through ordinary abrasions of the skin even in the presence of a large quantity of virus, it is improbable that man is ever infected in this way.

THE WOOD TICK.

The Life Cycle of the Wood Tick.

In order to understand fully the part which the wood-tick may play in the spread and maintenance of spotted fever, it is absolutely necessary to know something of its stages of development, its habits, its hosts, etc., in other words, its life history. This is not known completely, but a fairly good account can be given from the observations I have made, and this may be taken up before discussing more directly the transmission of the disease by the wood-tick.

The residents of the Bitter Root Valley have shown some confusion as to the number and varieties of wood-ticks. Probably only one species is commonly seen on the infected side of the valley and, so far as I know, this is true also of the unin-

fected side; this is the ordinary wood-tick, the scientific name of which is Dermacentor occidentalis. The confusion arises partly because the male tick is not differentiated from the female. Locally the female is usually described as the small red tick. It has a dark red or wine colored body, with a rather large, white, glistening disk just behind the head parts on the back. The male is commonly referred to as the small gray tick or the tick with the striped or spotted back. The striped or spotted back, which is more or less glistening in appearance, is analogous to the disk seen behind the head of the female, only in the case of the male it extends over the entire back and the colors are differently distributed. Also, the very large gray, or slate colored tick, which is nothing more than the fully developed female, is often spoken of as a different species.

I do not mean to deny the presence of other species of wood-tick in the Bitter Root Valley. Sometimes different species look so much alike that it requires a minute examination by a person of long experience in their identification, to differentiate them. It is quite certain, however, that the predominating tick in the woods is the one under discussion.

During the past year I have followed the life cycle of the wood-tick and shall summarize it briefly. The male and female are as described above. They feed in common on various animals in the valley and are seen together in large numbers in the spring and late winter, particularly on the domesticated stock which has wintered in the hills, or which frequent the hills for feed during the spring. During the course of feeding the male takes a position beside the female with the under surfaces of their bodies in contact, and fertilization takes place while they are in this position. I have recently noted that fertilization will also take place even when the ticks are not on an animal host. After fertilization has occurred the female continues to feed for several days, perhaps a week or ten days, and during this time enlarges very rapidly, until she is finally transformed into the large gray or slate colored tick. On the other hand, the male, after prolonged feeding, undergoes no more enlargement than would be caused by the distension of a good feed. The enlargement of the female is due partly to the quantity of blood it has ingested, but, in addition, the change is to be looked on as sexual. The ovaries become greatly developed and hundreds or even thousands of minute eggs begin their rather slow formation.

When the female has reached its greatest degree of enlargement it drops from the animal and, after a rest of about two weeks or longer in cold weather, begins to lay eggs. The eggs are withdrawn from the anterior end of the lower surface of the body, the head parts assisting in their extrusion, and they accumulate in small masses on the back of the head. As their bulk becomes heavy they fall off and are replaced gradually by a second mass. This process continues until all the eggs, which may number several hundred or even two or three thousand, lie in a heap before the tick. In the meantime the female becomes greatly flattened and wrinkled and, in a comparatively short time dies. A female which has laid eggs never again assumes the appearance of the young red female and her life is ended in one season. As to whether the unfertilized female ever lives more than one season, is a question yet to be determind, but the probabilities are all against it; the male probably lives but one season also.

In comparatively warm weather, as in July, the eggs begin to hatch within 30 to 50 days after they have been deposited. In cold weather it may be delayed for many months.

The ticks which emerge from the eggs are very minute objects with three pairs of legs, which at first are almost transparent, but in the course of a few days assume the reddish or yellowish-brown color which the body also acquires. If they are unable to reach an animal within the course of two or three weeks many of them die.

It has been observed in connection with other species of ticks that the larvae have the habit of "bunching" on the grass, or twigs of weeds or shrubbery, and in my experiments I have found that they have a great tendency to stick together in masses. Hence an animal which becomes infested with larvae at all is likely to have a large number attached.

Their viability also depends on the temperature and moisture of the air in which they are placed. Under the best conditions, even in the warm summer weather, some of them have lived for nearly three months. In somewhat cooler weather they may live longer. When exposed to direct sunlight they live a very short time.

There is but little doubt that the factors just considered help to explain why our tick is a wood-tick rather than a tick of the plains. In the wooded foot-hills or mountains the tempera-

ture on account of the elevation, is lower than it is in the flat valley, the atmosphere contains a greater degree of moisture on account of the abundant vegetation and the temperature at night is cooler than in the lower portions of the valley. All these conditions favor the life of the tick and enable it to tide over periods of hunger. It is, of course, possible for the wood-ticks to live in the open country, but it is a precarious life for them, and necessitates the almost constant presence of a supply of animals, in order that they may not be subjected to long periods of hunger. Another important element in making an open country an unfavorable place for the residence of a tick is the fact that the direct rays of the sun kill the tick rather quickly in all its stages, adult, egg, larval and numphal.

The woods furthermore afford protection for the host animals (horses, cattle, etc.) and since they frequent such places they readily become the prey of ticks, which in addition to having a constant food supply provided in this way, are surrounded by the conditions of moisture and temperature which favor their life.

When the larva is able to reach an animal it attaches itself to some delicate portion of the skin and feeds for from two to five days. During this time its original bulk is increased many fold, reaching about the size of the head of a pin, is somewhat elongated in shape and rotund, and of a color which varies from a light pink to a jet black. The color depends on whether the larva has fed mostly on lymhp or on blood, being darker in the latter case. Having fed to this degree it drops from the animal and in a few days becomes perfectly quiet as if dead. This, however, is only a quiescent or sleeping condition and after remaining in this state for about two weeks, it emerges, leaving behind a snowy white shell to which the old legs are still attached.

At this stage the tick is called a nymph. It now has four pairs of legs, is from one-twentieth to one-thirtieth of an inch long and at first has transparent or slightly yellowish legs and head parts, with a brownish black body. In the course of a week or ten days, the legs, head parts and also the back assume a rather dark, golden brown color, and only after this has taken place is it in condition to feed again. The feeding of the nymph extends over a longer period than that of the larva, but is complete in the course of from four to eight days. During this time it becomes greatly enlarged, its length and breadth reaching

about that of the full grown tick which is seen in the spring, and its covering is changed to a gray or slate color. At the end of this time the nymph also drops from the animal and wanders about for a period which depends very largely on the temperature of the surrounding atmosphere. At out-of-door temperature in Montana during the months of July and August it may remain alive and active two to four weeks. If it is placed in a refrigerator the activity may extend for more than three months. Eventually, however, it becomes quiescent, as did the larva, but the quiescent period is considerable longer than in the case of the larva. It may remain perfectly motionless, apparently as if dead, for from one to two or even three months, according as the temperature is higher or lower. This sleeping stage, however, is terminated by a repetition of the shedding process, only in this instance the tick comes out as the full grown male or female, which are so familiar in the spring. After a further period of intermittent rest and activity, the full grown tick is again ready to feed, and after fertilization of the female the cycle of development begins anew.

In the laboratory it was possible to hasten the entire cycle by always keeping the ticks with animals in order that they might feed at the very first inclination, hence during the past summer I was able to obtain many full grown ticks as early as September. Development does not progress so rapidly under natural conditions where the temperature is lower and where the ticks do not readily come in contact with their natural food supply, animal blood. I have, however, made sufficient observations of the tick in nature, to know approximately at what time it may be found in its different active stages.

During the past year, Mr. F. D. Nicols, of Hamilton, was influential in obtaining a large number of ticks from horses which had been in the hills all winter, the ticks being obtained from them in the latter part of December and the first part of January.

Ninety per cent of them were in the form of enlarged nymphs and in the course of a few weeks emerged from their white coverings as adult ticks. It is safe to assume that the larger percentage of these nymphs reached the horses some time during the early winter or late fall and on account of the colder weather had been sluggish in their feeding. If the nymph is found in this condition during December and January the larvae must exist

in an active condition during the latter part of the summer and the early fall, and I venture to say that a careful examination of horses and cattle, which have been in the woods during the fall, would reveal the presence of many of the minute larvae.

It is not to be understood that the seasonal distribution of the different stages of the tick is a sharp one. The eggs must, indeed, hatch out during the warm months of the year, but there may well be an interval of three or four months between the dates when the first and the last eggs of the season are laid. In the laboratory observations of the past year this interval was even more than three months. This means that the larval stage of the tick cannot be sharply limited, and this also must be true of the nymphal and adult stages. Last year (1907) I obtained some fully engorged females, ready to lay eggs, during the first of March; this was extremely early. They could also be obtained as late as the middle of June.

From what has been said, the supposed disappearance of the tick at about the first of July should be readily understood. The females which have been impregnated and have reached sexual maturity drop from the animals and lay their eggs; the females which have not been impregnated prolong their lives as long as the blood which they have ingested nourishes them, and then they die. The males which have performed the sexual function apparently succumb in a short time, and, quite naturally, all the ticks which have been unable to reach the animals die of starvation.

The remainder of the time until the next spring is spent by the tick in its earlier developmental stage, as described above.

Inasmuch as the female may lay two or three thousand eggs, it is manifest that only a small portion of the larvae reach the adult stage; otherwise there would be a massive increase in the number of ticks with each succeeding year. During all three stages there must be an enormous death rate among the ticks, in order to explain the fact that there is no great increase from a particular season to the next.

The wood-tick produces but one brood a year under natural conditions. Professor H. A. Morgan has informed me that another member of the same genus (Dermacentor) which inhabits Lousiana also produces but one brood a year. Professor Morgan believes that this is due largely to the fact that this tick drops from the host between its active stages, i. e., in order

to molt. The tick molts much more slowly, being off the warm skin of the animal, and this habit of dropping from the host entails a waiting period before the tick is able to find another host. Such conditions can only add to the length of the life cycle. This is in contrast to other varieties of ticks which pass almost their entire life upon the host.

Residents of the valley have often said that the tick "follows the snow line"; that is to say, the first ticks seen in the spring appear rather low down in the valley, but as the season advances they are found in higher altitudes, and farther back in the hills. I have found this to be true, and it is explained by the fact that the colder temperature of higher altitudes retards the whole life cycle of the ticks.

It is a point of importance to learn whether the tick may feed upon either living or dead vegetable material, as well as on living animals. Those who have spent a good deal of time in studying the habits of various ticks state that they are exclusively animal parasites or blood suckers. This is my own belief in regard to the Rocky Mountain wood-tick, although it may be desirable to carry out experiments bearing on this point. I have formulated such experiments.

It is remarkable that the larvae and nymphs feed on man so seldom. Twice I have found larvae and nymphs on the heads of children, but these seem to be exceptional instances. Further investigation will be needed before this point is thoroughly understood. Inasmuch, however, as it is the case and since it is practically only the adult tick which is found in the spring that feeds on man, the limitation of spotted fever to the spring is readily understood on the basis of the tick theory.

I may mention a phenomenon which has been described to me by a number of residents of the Bitter Root Valley. This is to the effect that the enlarged female gives birth to her young through a rupture of the body wall, the young emerging in herds from the body cavity of the dead female. It is a possibility that the female may die and give birth to her young in this way, the eggs hatching after the death of the mother. This would have to be considered as a very exceptional occurrence; among a large number of experiments I have failed to make any such observations.

Anyone may familiarize himself with the process by which the tick lays its eggs, and with the hatching of the latter by

placing one of the very large gray ticks found on cattle or horses in the spring, in a dry bottle the mouth of which is closed by tying a piece of muslin over it. If the tick is not injured the cycle may be followed as far as the hatching of the eggs and the appearance of hundreds of larvae. The experiment could not be carried further without placing the larvae on some animal.

EXPERIMENTAL WORK WITH THE TICK IN RELATION TO SPOTTED FEVER.

I do not know just how old the tick theory is, but my first knowledge of it came from the publication of Wilson and Chowning in 1902. It is said that it had a local existence prior to that time.

The arguments cited by Wilson and Chowning in favor of the tick theory are entirely circumstantial, but the conditions are such that this circumstantial evidence is of a rather strong character. As stated previously, the chief points in this evidence are that the spotted fever season opens at about the time the full grown tick begins to feed on man in the spring; that it closes in June or about the first of July at a time when the adult tick is no longer in evidence in low altitudes; and that practically all cases of spotted fever give a history of one or more tick bites within one or two weeks preceding the onset of the disease.

There are some who will take exception to the last statement and say that cases of spotted fever are known in which there were no histories of tick bites. It is not improbable, however, that the presence of ticks and tick bites is often overlooked. A number of individuals have told me of finding attached to some portion of their bodies ticks which were as large as the tip of the small finger. Now the tick which becomes so large is the female, and it requires several days' feeding before it can reach that degree of enlargement. Hence it is manifest that in such cases the ticks had been feeding for several days without the knowledge of those who were bitten. Concerning some of the cases of spotted fever which are reported not to have been bitten by ticks, it was said that the body had been looked over very carefully without finding a single tick which was attached. I can say from my own experience and from observations related by others that the tick will frequently bite for a short time, an hour or two to five or six hours, and will then

be dislodged by the rubbing of the clothing or will loosen of its own accord and drop off. Hence the failure to find a tick on the body of the patient does not rule out the possibility of a bite some days previously. My experiments show that an infected tick needs to feed only for a short time, a few hours at the most, in order to transmit spotted fever, and that it may have bitten the patient and dropped off a week before sickness began. During this time the wound caused by the tick may have healed entirely, or may remain only as a discoloration or slight wound which could not be distinguished from some other minor injury. Hence, failure to get a history of tick bite, or to find the tick or tick wound is not sufficient ground for denying the possibility of a tick bite. It should be borne in mind that it is difficult to discover ticks and tick wounds when they are situated on the scalp or hairy portion of the neck, where they occur not infrequently in cases of spotted fever.

It appears that the first experimental transmission of spotted fever by means of the tick was performed by Drs. McCalla and Brereton, of Boise City, in 1905. They gave their experiments no publicity and it was only recently that I learned of them from Dr. McCalla. They removed a tick which they found attached to a spotted fever patient, and allowed it to bite a healthy person, who after a period of eight days developed typical spotted fever. The experiment was repeated by allowing the same tick to bite still another person, with the same result. The consent of the patients, naturally, was obtained for the experiment, and little risk was involved on account of the mild nature of the disease in Southern Idaho.

My own experiments to determine the relationship of the wood-tick to spotted fever have been conducted entirely on the monkey and guinea-pig, especially the latter. Inasmuch as the guinea-pig is very susceptible to the disease, the results are as valuable as if the experiments had been performed on man, and indeed the latter method would have been out of the question.

In the summer of 1906 a female tick which had fed for about two days on a sick guinea-pig transmitted spotted fever to a healthy guinea-pig when it was allowed to bite the latter. Dr. W. W. King, of the Public Health and Marine Hospital Service, obtained a similar result at about the same time. A little later

in the same year I obtained a successful transmission with the male tick in the same manner, and repeated the transmission with the female a number of times. Some have wondered that the male tick is able to transmit the disease, since in some other diseases which are transmitted by insects only the females have the power of transmission. This is true of malaria, in which the female mosquito, but not the male, acts as carrier. The female, however, contracts malaria by sucking the blood of a malarial patient, and since the male is not a blood sucker it has no power of contracting and transmitting malaria. On the other hand, the male tick sucks blood as readily, though not to the same extent as the female, and has every opportunity to become infected.

The experiments just cited concern transmission by the adult males and females which are found in the spring in nature. As stated earlier, the tick passes through two active stages before it becomes an adult, i. e., the larval and nymphal stages. In considering when and where the tick gets the disease it must be learned whether or not it can contract spotted fever by biting some animal during these earlier stages; and if it can do this, whether or not it can retain the disease until it becomes an adult tick in the spring. If this proves to be the case, then it is evident that the tick which gives spotted fever to man in the spring may have contracted the disease from some outside source, either a short time before it bit the patient while it was in the adult stage or during the winter or late fall when in the nymphal stage, or in the fall or summer when in the larval stage.

In investigating these points, the experiments were undertaken on a large scale, in order that the results might be more satisfactory and to obviate the possibilities of error and failure. In determining whether or not the larvae can acquire spotted fever, the procedure was about as follows: Twenty or thirty normal females, i. e., uninfected females, were allowed to lay their eggs and as soon as the latter had hatched, from one thousand to six or seven thousand larvae were placed in tick proof cages with guinea-pigs which had been inoculated with spotted fever. That the females were not infected before they laid their eggs was proved by permitting them to bite healthy guinea-pigs. As the larvae fed, enlarged and dropped from the guinea-pigs which had been inoculated, they were collected and

placed aside until they passed through the first quiescent period and emerged as nymphs. As soon as the nymphs were sufficiently mature they were allowed to feed on normal guinea-pigs. The invariable result was that such guinea-pigs, in the course of a few days after the nymphs had begun to feed, developed a course of high fever and eventually showed all the symptoms which make spotted fever in the guinea-pigs characteristic and easily recognized. Out of twelve experiments of this nature all gave the same result. That is to say the larvae acquired spotted fever by feeding on infected guinea-pigs, retained the disease during the quiescent period, and showed their infectivity after reaching the second period of activity, the nymphal stage.

By using the same methods it was found that the normal nymph contracts spotted fever by biting a sick guinea-pig, retains it during its quiescent or molting period, and causes the disease in a normal guinea-pig when it becomes an adult male or female.

It is clear, then, that the tick may become infected during any one of its three active stages, and that it may acquire the disease at almost any time of the year, with the probability that the corresponding adults will be infective during the next spring. It is also evident how important it is for the complete solution of the problem to discover the animals on which the ticks feed during all three active stages, rather than confining such observations to the spring when the adult tick alone is active. I had it in mind to investigate this point during the past year, but the volume of experimental work was so great that this had to be postponed until a more convenient time.

HEREDITARY TRANSMISSION OF SPOTTED FEVER IN THE TICK.

How is spotted fever kept alive from one year to the next? This question has undoubtedly entered the minds of all who have thought seriously on the subject. Is there present in nature some animal which harbors the disease continuously and in chronic form, which may infect the tick whenever the latter feeds upon him, or does the disease exist in an acute form in some one of the local animals so that it is transferred from animal to tick, and again from tick to the animal, producing an endless alteration of the infection? Or does the virus flourish in some form of decaying vegetation from which the

tick may become infected during temporary feeding?

I shall not discuss these points further at this time, but shall cite experiments which show at least one method by which the disease may be passed from one spring to the next. This has to do with the transmission of spotted fever from an infected female to her young through the eggs. Experiments of this nature were carried out on a large scale during the summer of 1907. In the neighborhood of sixty females were allowed to feed on diseased guinea-pigs. Those which were not already fertilized were placed with males on infected guinea-pigs until they were ready to lay eggs. About one-half of the females failed to lay eggs, but twenty-six experiments were carried to completion. After the eggs were hatched the larvae of each female were allowed to feed on a healthy guinea-pig, in order to determine whether or not the young ticks were infected with spotted fever.

Without going into further details, I may simply state as a result of this work that two of the infected females transmitted spotted fever to their young through the eggs, i. e., the guinea-pigs which were bitten by the young broods developed spotted fever.

The continuation of these experiments has shown that the larvae when once infected by the female parent, retain the disease until they become nymphs, and, as stated previously, the infected nymph also keeps the disease until she becomes an adult. It seems quite certain, on the basis of these results, that the female tick which becomes infected from whatever source is, in a certain percentage of cases, responsible for the appearance of infected ticks during the next season.

It seems somewhat surprising, since transmission occurs at all, that it was obtained in only two out of twenty-six experiments. This cannot be accounted for at present, and we must simply take the results as we find them. If this was the result in twenty-six laboratory experiments, the laboratory in this case being in the open air, it is fair to conclude that the same condition prevails in nature, i. e., that only a small percentage of infected females passes the disease on to their young. This result may help to explain the comparatively small number of infected ticks in nature.

THE EXISTENCE OF INFECTED TICKS IN NATURE.

Although the experiments cited go to show a very intimate relationship of the virus of spotted fever to the tick, there remained one further point to be worked out before the tick theory could be accepted without reservation. This has to do with the existence of infected ticks in nature. In view of the small number of cases of spotted fever which develop each spring, in comparison with the large number of persons who are bitten by ticks, it was suspected that the number of infected ticks in nature is very small, and the search promised to be a difficult one. For the purpose of the experiments several hundred ticks were collected from the woods and from horses and cows in the districts which were known to be infected at the time, and these ticks were placed on normal guinea-pigs in groups of from twenty to fifty, the ticks in each case being allowed to feed for a time which was known to be longer than that required to produce spotted fever. The experiments resulted in the discovery of one or more infected ticks among a group of thirty-six males, which were collected from the immediate vicinity of a case of spotted fever which occurred in May. Just how many of the thirty-six ticks were infected could not well be learned, but the experiments do show very clearly that the number of infected ticks in this infected locality was very small. The result helps still further to explain the small number of cases of spotted fever, and why so many who are bitten by ticks do not contract the disease. It also completes the chain of circumstantial evidence which, all considered, renders necessary the acceptance of the theory of transmission by the tick.

SUMMARY OF FACTS WHICH SUPPORT THE TICK THEORY.

I may briefly summarize the experimental results and the clinical observations which prove the tick theory and render it imperative to attempt a fight against the disease on this basis.

First, the disease is limited to the season of activity of the adult male and female ticks, which in contrast to the larvae and nymphs, feed readily on man. Second, in practically all cases of spotted fever it is possible to obtain the history of a recent tick bite, and from experiments performed on animals with the tick, it has been learned that the period between the

tick bite and the onset of fever in the animal, corresponds closely to this period as observed in man. Third, infected ticks exist in nature in the so-called infected districts. Fourth, the relation of the virus of spotted fever to the tick is very intimate in its character, a fact which is shown by the ability of the female to infect her young through her eggs, and also by the fact that either the larvae or nymph may acquire the disease by biting sick animals, and retain it during molting and the subsequent active stages. In other words, the relation of the virus to the tick is of a very special character and it may exist in the tick for a long period, apparently without doing the tick great injury.

When we consider certain analogies in which other diseases are transmitted by insects, our willingness to accept the tick theory of transmission receives further justification. In the case of malaria, for example, it is known that a particular mosquito transmits the disease and there is no other way by which it is acquired naturally except through the bite of this particular mosquito, which must first have acquired the infection by biting a previous malarial patient. The conditions are similar in relation to yellow fever, which is transmitted by another species of mosquito, to the "tick fever" of man in South Africa, the "tse-tse" fly disease of Africa, and others. Such relations tend to give the impression that, when a disease is habitually transmitted by the bite of an insect, and when the relation of the virus to the insect is a very intimate one, that this is the only natural means by which the disease is acquired. This is not a thoroughly scientific conclusion, but in relation to spotted fever, practically all other avenues of infection have been ruled out. The disease cannot be acquired through the digestive tract, nor through the ordinary abrasions of the skin, as shown by the animal experiments, whereas the tick becomes infected readily, retains the disease a long time, and when once infected will produce the disease in susceptible animals as often as it can be induced to bite.

CONCERNING THE ORIGIN OF SPOTTED FEVER.

We do not know and probably never can know how the virus of spotted feved came into existence. It cannot well be doubted that new germ diseases appear in man from time to time. However, this does not indicate that a new germ suddenly sprang into existence, but suggests other alternatives

which are more probable. If a new disease appears in a locality but recently settled, it may be new only because the microbe had no previous opportunity of infecting man. Prior to this time the germ may have lived in nature for a long period, subsisting either on decaying vegetable or animal matter, or as a parasite on living plants or in living animals. If a new infection develops in a locality which has been long inhabited, it is probable that the microbe existed in nature for a long time previously and only acquired virulence for man through a long course of time and because of some unknown influence. As to which of these conditions prevailed in regard to spotted fever we are entirely ignorant.

It is difficult or impossible to obtain a satisfactory idea as to how long spotted fever has existed in the Bitter Root Valley, as a disease of man. It seems not to have been present among the earliest settlers, or if present, was not recognized. At present the old settlers give different reports concerning the first case in their memories, but it is difficult to trace the disease in the white man to a point beyond 1885 to 1890, and accounts given by the older physicians are of a similar nature. The latter have often raised the question as to whether spotted fever is identical with a disease which bore the name of "black measles"; it is said that the latter disease, or rather the latter name, began to disappear at about the time spotted fever came to be recognized. It is rumored that the Indians who formerly lived in the valley suffered from "black measles" and that they shunned the western slope of the valley (now infected with spotted fever), in the spring. I hardly considered this information authoritative as it came to me, and being busily engaged with the immediate problem, I have deferred a closer inquiry into the history of the disease, although it is very desirable that this be undertaken.

From what source does the tick become infected with spotted fever? It is very desirable to have positive knowledge on this point, for it is possible that spotted fever might be exterminated by destroying the natural habitat of the virus (animal or vegetation), if the habitat should chance to be open to destruction. Unfortunately it is a difficult problem to determine the natural habitat of any virus, and often it seems to be entirely beyond the reach of experimental determination. At this time we can do no more than consider the subject from the

theoretical standpoint, and indicate certain probabilities.

Is it possible for man to be the source of infection for the tick? This is a pertinent question, for in cases of at least two other infections, malaria and yellow fever, man is the only known source from which the insects (mosquitoes) derive their infection. If this were rigidly true in relation to spotted fever, it would imply that female ticks occasionally feed on spotted fever patients, then drop off and reach some other animal on which they become sexually mature, so that they are in condition to lay eggs. It is very improbable that the tick ever reaches this degree of maturity on spotted fever patients, or if so, that it is an exceedingly rare occurrence. The conditions militate against it strongly. In the first place spotted fever patients are looked over for ticks pretty thoroughly and those which are found are destroyed. Again the chance of a tick reaching a second host is small. Sometimes an infected district passes through a year without having any cases of spotted fever. During such years there would be no chance for the infection of ticks from man, and the disease would be in a fair way to die out in that locality, if there were no other source for the virus. This has not been the experience, however, for a district which escaped spotted fever for one season may furnish several cases during the next year. This was the history of the Lo Lo Valley during 1906-1907.

There remains only one other possible way by which the disease could be maintained if human patients were the only source of infection for the tick. This concerns the continuous transmission of the virus in the tick from generation to generation, after the initial infection was obtained from a patient. Whether or not this can occur is open to determination experimentally, but has not yet been investigated.

I can only express my belief, which is founded on the preceding considerations, that man is not the source from which the tick usually derives its infection ,although this may take place rarely.

In a particular household it may happen occasionally that one or more ticks which are attached to a spotted fever patient become free, and a short time later take hold of another member of the family, infecting him with the disease. This would be analogous to the conditions which exist in relation to malaria and yellow fever. Possibly this happened in one instance in

1906. In this case the mother, on the day after attending the funeral of her child which had died of spotted fever, also became sick and developed the disease. Such instances are rare.

The conditions are a little different when two members of a family develop the disease at the same time. In 1906, a father who worked at a saw-mill in the foothills, often brought ticks home on his clothing. He and his infant son both became sick with spotted fever on the same day. In all probability he had brought an infected tick home, which after biting him became detached and reached the child. They slept in the same bed. Or he may have brought home more than one infected tick, one or more of which bit both the father and the child.

It seems that we are almost compelled to conclude that there is some natural source for the virus, other than man, from which the tick, in feeding, becomes infected.

I have spoken of living or decaying vegetation as a possible home for the micro-organism. This can be entertained only if one assumes that the tick feeds on such material. I say **Assumes**, because there are no direct observations to show that such is the case. Hence this possibility is the barest hypothesis, and it may be disregarded until experiments show that living or decomposing vegetation may serve as food for the tick. Specialists on insects have told me that they do not believe that this is possible.

In preceding pages I have referred several times to the possibility that there is some local animal which is susceptible to spotted fever, and that the disease may be maintained from year to year by alternating between this animal and the tick. I have also referred to a number of experiments bearing on the susceptibility of local animals. Many animals remain to be tested, hence a satisfactory discussion of the subject cannot be given at this time. As stated, the susceptibility of the horse and sheep is low, and apparently it would require a large number of infected ticks to produce spotted fever in either of them. In case this did occur however, it would give opportunity for infection of all the ticks which happened to be feeding at the time, and in this way a considerable number of infected ticks could be accounted for. The one calf which was tested was entirely insusceptible; adult cows have not been tested. It seems unlikely that any of the domestic animals play a part in maintaining the disease, inasmuch as their susceptibility is so low.

The gopher is the only native wild animal studied so far which is reasonably suceptible to spotted fever on inoculation, although it is much more resistant than either the monkey or the guinea-pig. Of about twenty which were tested, only one died of the disease, and less than fifty per cent of the number reacted at all. This irregularity is so singular that further investigation of the subject is demanded. As I shall emphasize later, one attack of spotted fever confers immunity against further attacks. The possibility at once comes to mind that the resistant gophers had previously passed through spotted fever in nature, and hence were immune and that the susceptible gophers were those which had not suffered from the disease previously. No opinion can be formed on this point at present.

The susceptibility of the rabbit (domesticated) was referred to on a previous page.

I obtained the impression that the gopher is sufficiently susceptible to play a part in the maintenance of spotted fever, although I do not consider the point as scientifically demonstrated. More accurate information is needed concerning the extent to which the gopher is infested with ticks during different seasons of the year. The susceptibility of the native wild rabbits remains to be investigated.

In attempting to solve this phase of the question it is desirable to discover all possible hosts for the tick on both the infected and uninfected sides of the valley. I think it is manifest that this line of research would be of value only when one compares the conditions on the uninfected side of the valley with those on the infected side. And, as stated previously, it is important to discover the hosts, not only for the adult which predominates in the spring, but also for the larvae and the nymphs, and this demands that the search be prolonged throughout the entire year. This is necessary, in view of the fact, which has already been stated, that the tick may acquire the disease either as a larva or as a nymph.

CONCERNING THE DISTRIBUTION OF SPOTTED FEVER IN THE BITTER ROOT VALLEY.

It is a curious circumstance that the east side of the Bitter Root Valley has remained uninfected, although the disease has flourished on the west side, within a few miles, for so many years. This point demands some consideration, since the situation is well known in the valley, and since also it raises the

question as to whether spotted fever is likely to extend beyond its present limits.

It is now imperative to treat of these questions on the basis of the tick theory, and unfortunately they cannot be discussed with the desired thoroughness until further investigations are completed. Hence a presentation of the subject at this time must be more or less hypothetical.

We may first consider certain differences between the east and west sides of the alley, which probably exert an influence on the life of the tick and in this way affect the geographic distribution of spotted fever. On the west side the valley is rather narrow in most places and the foothills lie nearer the river. The mountains are higher, more snow falls on them, there are more streams than on the east side, and the mountains and hills are, or have been, heavily wooded. The timber on the west side lies close to the highways and the railroad, hence is easily reached, and, because of the lumber industry, has been inhabited rather extensively. On the east side the open land and naked "benches" are much broader and a large percentage of the population does not come in contact with the woods a great deal. Less snow falls, there are fewer streams and the timber is rather remote from the more populous districts, from good highways, and from the railroad. Hence the conditions are not so favorable for the lumbering and mining industries, and the hills are not populated or frequented so much as on the west side.

In defining the timber limits we also define the home of the tick to a large extent. It is probable that, before the valley was settled, the ticks were confined to the timbered districts even more than they are now, as the native animal life, the hosts for the ticks, is so largely confined to the woods. Since the valley has been settled the introduction of domestic animals has served to bring the tick more into the open country and hence to bring man and the tick into closer contact. Although we may not understand all the reasons, it is nevertheless true, as stated before, that our tick is essentially a wood-tick, that it thrives in a wooded much better than in an open country, even though the number of animals is approximately the same in both places. The ranches which are situated on the timbered foothills and "benches" are infested with ticks to a much greater extent than those which are lower down. This is true of the west as well

as the east side. It is not unlikely that the woods and brush afford some protection for the tick, especially from the drying effects of the sun, and that the higher degree of moisture in a wooded country, which abounds in streams, prolongs the life of the tick. These influences are felt particularly by the delicate larvae and nymphs.

A country which contains many young trees and much brush also favors the life of the tick in this, that greater opportunity is afforded them for coming in contact with animals. In the first place both domestic and wild animals resort to such places for shelter and food. Then, too, the tick has a strong instinct for climbing, and reaches low heights on brush and young pines. From such places they come in contact with the broad sides and heads of animals, thus finding hosts more readily. When one walks through timber which contains grass, low bushes and small pines, the larger part of the ticks which he collects on his clothing are first seen on the legs, but a fair proportion seize the clothing of the upper part of the body.

Whether or not the reasons given explain sufficiently the cause, it is nevertheless true that comparatively few ticks are found in the open country, and that timbered districts present the conditions under which they flourish.

This has its application in the fact that the east side of the valley is largely an open country, that the majority of the people are rather remote from the woods, and hence do not come in contact with the ticks to a great extent. On the other hand the foothills of the west side approach nearer the river, a larger number of people live in the tick-infested country, and many more are exposed to the bites of ticks.

ARE THERE INFECTED TICKS ON THE EAST SIDE OF THE VALLEY?

I do not maintain that the above considerations are sufficient to explain the entire absence of spotted fever from the east side of the valley in past years. There is a sufficient number of ticks on the east side, and a sufficient number of people are bitten by ticks, to provide an occasional case of spotted fever, if infected ticks were present in the same proportion as on the west side. Hence it is probable either that there are no infected ticks on the east side, or that they are present in still smaller numbers than on the west side of the valley.

In bringing up this point, however, we have to remember

that several cases of spotted fever occurred on Rock Creek not long ago, just over the range east of the Bitter Root Valley. We know, therefore, that there are, or have been, infected ticks on Rock Creek. This presupposes that there exists, or has existed on Rock Creek, a source, perhaps some animal, from which the tick can become infected with spotted fever, and just at present Rock Creek is inhabited so little that the absence of the disease from man in recent years cannot be taken as proof that the locality is no longer infected.

It is reasonable to assume that the conditions on Rock Creek cannot be very different from those in the hills on the east side of the Bitter Root Valley; that, if some animal exists on Rock Creek, which is susceptible to spotted fever and from which the tick can obtain the infection, it probably exists also on the opposite side of the range in the Bitter Root Valley.

This statement should not excite undue alarm, for we still have before us the fact that cases of spotted fever have not originated on the east side in past years, and that there is likelihood that this state of affairs will continue to be the rule. Nevertheless the possibilities should be considered frankly.

The possibility of infected ticks being carried from the west side by horses, cows or individuals, and occasionally causing the disease on the east side, must be considered. Without doubt ticks are carried from the west to the east side every year, but there are a number of conditions which operate against spotted fever being transferred to the east side in this way.

There are uninfected as well as infected districts on the west side, hence the possibility of infected ticks being carried over is affected only by such communication as takes place between the east side and the infected districts of the west side, rather than between the east side and the west side as a whole.

Furthermore, the number of infected ticks on the west side, even in infected districts, appears to be quite small, as indicated in the experiments described on a previous page, and on the basis of this proportion it is evident that a rather large number of ticks from infected districts could be carried over before an infected tick would be included in their number.

Assuming that an infected tick may occasionally be transported to the east side, the possibility of man being infected with spotted fever from such a tick is exceedingly small, because of what we may call the life expectancy of any indi-

vidual tick. (In nature the chance of any particular tick finding a host is very small, and the large number of eggs which the female lays is nature's method of counteracting the low life expectancy of the individuals). The chances are that such a tick would find a host only in very rare instances.

CONCERNING THE POSSIBILITY OF EXTENSION IN OTHER DIRECTIONS.

Spotted fever for some years has been sharply limited on the north by the Lo Lo Valley, and inasmuch as the country north of the Lo Lo is inhabited, this has seemed to be a genuine limitation. There is reason to think that this is only an apparent limitation, however. It seems probable that there is not much danger of rapid extension toward the north, but it is worth while to remember that in 1906, Mrs. C———, living on Hayes Creek, north of the Lo Lo, died of spotted fever. The family of C——— had had cows in the Lo Lo Valley during the winter and in the late winter or spring they were brought home. Mrs. C——— milked the cows and the latter may have brought one or more infected ticks home with them, one of which later transferred the disease to the woman.

I may mention also that Grant Creek was infected a few years ago.

Toward the south cases have occurred as far as Darby, according to the report of Wilson and Chowning. We cannot be certain, however, that this latitude represents the southern limit of the infection, since below this point the valley is sparsely populated.

This question, however, is purely a hypothetical one at present, and must remain so until it has been worked out experimentally.

PREVENTIVE MEASURES.

In attempting to wipe out an infectious disease it is desirable to find the primary source if it is suceptible to determination. If, for example, it should be discovered that the gophers or the wood-chucks are the primary hosts for the microbes of spotted fever, and that the ticks acquire the disease by biting them, the problem could be attacked logically and without great difficulty, by poisoning the gophers or the wood-chucks. The investigations have not gone this far, however, and no assurance can be given now that this phase of the problem will be

solved. We must therefore proceed along such lines as our present knowledge indicates.

It is sometimes possible to protect man from a disease by suppressing the means of its transmission, whether the original source of the virus is known or not. This, in addition to quarantine measures, is the practice which has been so successful in combatting malaria and yellow fever, and, I may add, the Texas fever of cattle, which, it is generally known, is caused by the bite of the cattle tick. In regard to malaria and yellow fever this is done by destroying the breeding places of the mosquitoes; killing the mosquitoes in houses by fumigation; screening houses to protect the healthy from mosquito bites; and screening the patients to prevent mosquitoes from becoming infected. It is more pertinent to our subject, however, to known that Texas fever of cattle is being rapidly weeded out of the southern states by the systematic extermination of the cattle tick. In view of the success which has attended these efforts, and in view of the fact that spotted fever is also transmitted by a tick, it is necessary to consider seriously the advisability of attacking the spotted fever problem by a campaign of eradication of the wood-tick.

TICK ERADICATION.

It has been stated frequently in the Bitter Root Valley that if the scientists prove the tick theory to be correct, they are under obligations to find some way of getting rid of the tick; and there is a fairly widespread belief locally that the only way this could be accomplished would be to burn over the territory, the woods, which is known to harbor infected ticks. This would cause an enormous destruction of property, and, moreover, there is every reason to believe that it would not be effective. It would of course kill a great many ticks, that is, it would kill those which happened to be in the woods, but would in no way affect those which are attached to animals. The consequence of this would be that the woods would again become infested from the ticks which had been able to mature on animals and subsequently to lay their eggs.

One gets at the root of the question of tick eradication, not by forcibly destroying those which exist free in nature, but as is done in the south, by destroying the adult breeding ticks, or by a process of starvation of the tick.

The methods to be employed depend entirely on a correct knowledge of the life and habits of the tick. It is a point of first importance that the tick cannot perpetuate itself without sucking animal blood. It may indeed derive a certain amount of nutrition from vegetable matter, enough to tide over a period of hunger, until it can reach an animal host. It is not generally believed by scientists, however, that ticks can subsist on vegetable matter even to this extent. However this may be it is impossible for the female tick to reach the great development which is necessary before it can lay eggs, without a prolonged feed on animal blood; and if females can in any way be prevented from laying their eggs it is manifest that great inroads would be made on the crop of ticks for the following year. The methods of picking and oiling the cattle at the proper time of the year, as practiced in the south, depend entirely on this principle.

It is also an important fact that the tick in its development passes through a definite annual cycle, that there is only one reproducing season for the Rocky Mountain wood-tick, that is during the months of spring. Hence if it seemed advisable to begin a campaign of tick eradication by destroying the breeders this work would be confined roughly to the spring.

The fact that the tick passes through a definite annual cycle is also important in extermination by the process of starvation. Inasmuch as the adult ticks, the breeders, are active only in the spring, it is manifest that they will soon die if they do not reach animal hosts during this time, and with the death of the breeders a crop the following spring becomes impossible. This principle has been acted on in the south with great success, the result being accomplished by keeping the stock away from the tick-infested pastures during the "breeding season."

I may take space to go into a little more detail concerning the different practices, leaving the question more or less open as to which would be best suited to the conditions in the Bitter Root Valley.

PICKING AND OILING.

Picking may be practiced alone, or in combination with oiling, or oiling alone may be practiced without taking the trouble to pick the ticks off. If picking alone were to be practiced it would be necessary to go over the stock thoroughly every four or five days; this should be done in an enclosed lot

which was used for no other purpose. It would be necessary to begin the process not later than the first of March or the middle of February, and to keep it up until the adult ticks have disappeared from the woods, that is, until the stock which frequents the woods for pasture bring no more ticks home with them. The question arises as to whether it would be necessary to care for stock in this way, when the animals are turned into an open pasture instead of into the woods. This depends entirely on whether or not the pasture is infested with ticks, for it is quite possible for an open pasture to become infested with ticks in case stock has been kept on it more or less constantly.

The method of picking alone is so arduous, disagreeable and not likely to be thorough, that the advisability of practicing it may be open to question. It would be practicable only with a very small herd.

Oiling is accomplished in different ways. Some crude and inexpensive oil is used, such as crude petroleum. In the south the Beaumont (Texas) oil is used extensively. In some sections where a great deal of stock is concerned dipping stations are established, whereby a large number of animals may be dipped in the oil in a comparatively short time. More recently an improved method of applying the oil by means of a spray has been practiced in some localities and it seems to be effective. It may be applied also with brushes, with cloths or with the naked hands.

From the reports issued by the Bureau of Animal Industry in Washington the oil seems to be effective, at least in part, because of the great repugnance the tick has for it. It causes those which are attached to loosen their hold, and when oiled animals are turned into fields which are infested with ticks the latter refused to attack them. In case the oil is applied very thoroughly, as in dipping, the ticks which are attached may be suffocated by virtue of the oil stopping up their breathing pores.

One application of the oil seems to be effective for some time, often several weeks, hence it has this advantage over the method of picking the ticks off. It seems probable that four or five applications at proper intervals during the spring would be sufficient. The first application should be made not later than the first of March and possibly as early as the middle of

February, and the treatments should be kept up until about the first of July. It is true that adult ticks may be found later than the first of July, especially rather high in the hills, and they may also be found earlier than the middle of February, particularly when the winter has been warm, but this is more or less exceptional; the limits mentioned above include the period of activity of a very high percentage of the adults, and low down in the hills and in the valley, practically all of them are included.

It is believed in the south that oiling produces no permanent injury to the stock, and from the fact that it need be practiced only over a small portion of the year, the possibility of injury to the stock is not a serious question.

STARVATION OF THE TICK BY THE MANIPULATION OF PASTURE.

Feeding in Tick-Free Lots.—The simplest way to starve the ticks would be to feed all stock in tick-free lots at home during the spring months, first being certain that the animals were free of ticks before they were placed in the lots. The result of this would be that the ticks in nature would have no opportunity to mature and lay eggs, hence the prospects for a crop of ticks for the next year would practically be blotted out. This method would entail some hardships, as it would deprive the ranchers of natural pasturage during the spring and make the feeding more expensive.

Alternation of Pastures.—In case a rancher has two pastures, eradication of the ticks on his pemises can be accomplished in the following way: The stock can be kept in one of the pastures during the coming spring, the other pasture remaining entirely free from animals, and during this time the ticks which become attached to the animals in the first pasture, will mature and drop off into the field. At the end of this time, i. e., some time during the first part of July, when all the ticks have dropped from the animals in the first pasture, the stock should be transferred to the second pasture. The second pasture is free of ticks by this time since all those which were originally present have starved from the lack of an animal host. Consequently when the next spring comes the stock should be entirely free from ticks. In the meantime the ticks which matured on the animals while they were in the first pasture, have laid their eggs some time during the summer or early fall and the

young larvae have hatched out. Inasmuch, however, as the pasture is now free of animals, the larvae have no opportunity to feed and soon die of starvation. Consequently some time during the next spring the first pasture is also free from ticks, and grazing could be permitted indiscriminately over the whole pasture.

In case a rancher has only one pasture the same result could be accomplished by putting a moveable fence across the middle of the field and proceeding as outlined above. When the stock is transferred to the second field the fence should also be moved over about ten feet in the same direction, so as to render it unlikely that ticks would crawl from the first pasture into the second. Among some other species of ticks which have been studied in this particular, it has been found that they never move more than a few feet from their original position. The rancher who has two pastures would also have to take this precaution in case they were separated only by a fence.

ARE THESE METHODS APPLICABLE TO THE CONDITIONS IN THE BITTER ROOT VALLEY?

Naturally the question will arise as to whether methods which have been successful in the eradication of the cattle tick in the south will be equally suited for the eradication of the wood-tick from the mountainous districts of Montana.

In answer to this question it must be stated that total extermination of the tick cannot be promised or expected, when it is remembered that certain of the native wild animals act as hosts for this parasite. Deer and elk harbor them in large numbers, but these animals can play no great part in infesting land which is under cultivation and in close proximity to human residence. They are responsible for the infestation of the hills in certain parts, but not the cultivated fields. This is an important distinction. The wood-tick undoubtedly inhabited the hills before the valley was settled and domestic animals were introduced, and they will continue to do so, as long as there are wild animals on which they can feed and mature. But this does not mean that the territory inhabited by the residents must continue to be infested with ticks, if the proper precautions are taken. Wild animals play little part in depositing ticks in close proximity to human habitation. They range in such places only to a limited extent. The ticks which exist on a ranch and in fenced pastures, have for the most part been

brought there, from the hills, by the horses and cows, and it is these which are the greatest factor in keeping ticks alive in proximity to man. It is a common experience of those who have lived in the valley for many years that the number of ticks has increased enormously as the valley has become settled and as more stock was introduced. This is readily understood when one sees the hundreds and thousands of ticks which are attached to the stock in the spring.

On the basis of what is known about the life and habits of the Rocky Mountain wood-tick, it can be stated that the methods outlined above will be successful in proportion to the thoroughness with which they are carried out.

CHOICE OF METHOD FOR THE BITTER ROOT VALLEY.

There are two conditions which point to the oiling method as the preferable one for the Bitter Root Valley, if it seems best to select any one method to the exclusion of others.

The first, and perhaps the most important, is the fact that there is a good deal of indiscriminate grazing, which of course is incompatible with the segregation of the stock for the purpose of starving the ticks. By the enacting and enforcing of suitable regulations it might be possible to prevent this free grazing to a certain extent. However, the probabilities are that it could not be prevented entirely, and that irregularities would render the attempt at eradication ineffectual. Furthermore, there is more or less unfenced grazing land in some portions of the hills, so that uniform enforcement of the principle of segregation could not be attempted until the necessary fences are constructed.

Second, the fact that the gopher and perhaps other small animals act as hosts for the tick to a certain extent, would complicate the extermination of the tick by the method of rotation of pastures. This is a peculiarity of the problem in the Rocky Mountains, which those who are fighting Texas fever in the southern states do not have to deal with to a troublesome degree. In the south the cattle are practically the only hosts for the cattle tick, hence the farmer who takes his cattle from a particular field can feel fairly sure that no animal is left on which the remaining ticks can mature. In the Bitter Root Valley, however, we are not so sure but that a certain small number of ticks would feed on other animals, and if the

cattle were unprotected by oil during the spring such ticks would be given an opportunity to mature and lay eggs.

For these reasons it seems probable that the oiling method is the method of election for the Bitter Root Valley. This is the view of Prof. H. A. Morgan, of the Agricultural Experiment Station, University of Tennessee, who has kindly studied the situation at my request.

The oiling method also has the advantage that it causes the rancher less inconvenience and expense than any other.

OTHER PREVENTIVE MEASURES.

What can be done as a more direct and more immediate preventive of spotted fever than the method just cited? There are at least two points to be mentioned which are perfectly familiar to those who live in the Bitter Root Valley. It is important to avoid exposure to tick bites as much as possible during the spring when the adults are active. Those who work in infected districts should examine their clothing and body frequently for the presence of ticks. In the case of a tick bite I consider the following as the proper method of treatment: The tick, if attached, should be removed immediately, not by attempting to "unscrew" it as is so often recommended, but by grasping the body firmly and pulling gently and continuously until the animal relaxes its hold. A sudden jerk is likely to tear the body from the head, leaving the latter imbedded in the skin. A drop of kerosene oil will cause the animal to loosen its hold. The method which I commonly use in removing ticks from animals is to insert a needle beneath the heal of the tick and through the uppermost layer of the skin, which has become softened by the bite, then to pry directly outward with the needle. This removes a small fragment of the epidermis, and with it the tick. A tick which is removed should be killed at once, for if it happens to be infected and is allowed to go free, it may subsequently become attached to another person in the same household, or it may by chance fasten to an animal, and, if it is a female, may be responsible for the appearance of a large number of infected ticks during the next season.

A much used treatment for the tick-bite is to apply some strong carbolic acid, either with the stopper of the bottle or by inverting the bottle of acid over the wound. This is both inefficient and dangerous, inasmuch as it burns an excessive

area of the skin. In biting, the tick inserts its fine toothed proboscis for a short distance into the skin and it is here that the spotted fever germs are deposited; hence the proper method of applying the carbolic acid, and I know of no better caustic for the purpose, is to dip a sharp pointed toothpick or splinter of wood into the acid, allowing only a small drop to adhere, and then to thrust the tip deeply into the point of the bite, twisting the wood as it penetrates. The first application is rather painful, but the acid has a tendency to destroy the sense of pain, and the second and third applications immediately following may be made with a small degree of discomfort. The wound crusts quickly and heals without further treatment. We have, as yet, no experimental evidence to show just how effective cauterization of the tick wound with carbolic acid is, in preventing spotted fever. The application should be made immediately when the bite is discovered. The virus in a short time probably extends too far for the acid to have any effect on it.

SERUM PREVENTION.

When animals recover from spotted fever they are immune to further attacks, and their blood has the power of protecting other animals from the disease. Thus I have found that from one to two or three drops of the blood of an immune guinea-pig will protect a healthy guinea-pig against thirty to one hundred times as much virus as is necessary to cause spotted fever. If one injects a cubic centimeter (about 15 drops) of immune blood into a healthy guinea-pig, the animal is protected against spotted fever for several weeks. However, this protection is not permanent, disappearing in thirty to forty days.

I do not doubt that this serum will also protect man against spotted fever if it is injected soon after the tick bite. One cannot tell an infected tick from a healthy one by looking at it, or by examining it with the micrscope. This can only be determined by allowing the tick to bite a guinea-pig, and so much time is necessary for this that the person who was bitten is either out of danger from spotted fever, or has become ill with the disease, before the result of the test could be learned. Hence, if one instituted this sort of prevention, it would be necessary to give the serum to all who were bitten by ticks, without waiting to see which persons would have spotted fever. As in the case of the animals, the protection would not be

permanent and might not last longer than two or three weeks. This would be long enough however to protect the person from spotted fever in case the tick which bit him was infected.

It is not likely that there will be sufficient serum to carry on this sort of prevention during the coming year.

PREVENTION BY VACCINATION.

I have developed a method of vaccinating the guinea-pig against spotted fever so that he remains immune, at least for several months, and the indications are that it will last much longer. That this immunity is associated very closely with the tissues of the animal is shown by the fact that a vaccinated female transmits her immunity to her young.

This is the method of "mixed immunization," concerning which I prefer to make a special report to you at a future date. It is not yet sufficiently perfected to justify its use in man, but the subject is being studied carefully with the hope that, in the end, it will yield a satisfactory means of vaccinating man against the disease, so that the protection would be of long duration.

CURATIVE MEASURES.

I have no report to make on the effect of drugs on spotted fever. This subject is now being studied in the laboratories of the University of Chicago.

A satisfactory serum therapy, by means of an antitoxin or similar serum, has not yet been worked out. The serum referred to above does have some curative power provided it is given on the first or second day of the fever. It does not cause a prompt cure of the disease, but in the guinea-pig shortens the course of the fever by two or three days. In the case of man it may be the means of making the disease less virulent, so that a greater proportion of patients would recover than heretofore, but the outlook for an effective curative serum is not promising.

Unfortunately the only source for the serum at present is the guinea-pig, hence it is not possible to obtain it in sufficient quantities for general use at present. An attempt will be made to find a suitable larger animal from which an equally good serum might be obtained in quantities.

RECOMMENDATIONS.

On the basis of observed facts and the deductions which we may reasonably make therefrom, I recommend:

1. That the residents of the Bitter Root Valley be instructed on the points brought out in this report, especially in regard to the correctness of the tick theory, the life history of the tick, and the part the stock and other animals play in the maintenance of the tick.

2. That an active campaign be instituted for the eradication of the tick in areas known to be infected with spotted fever.

A thorough inspection of the valley, especially the west side, should be made, in order to determine the methods which would best suit the conditions of the ranchers. It may be desirable to divide the valley into districts, and to have an inspector for each district, in order that the conditions of each rancher may be understood, and that the intelligent co-operation of the residents may be obtained.

The exact measures and regulations which will be necessary to carry on such a campaign successfully can best be determined after the local conditions are thoroughly understood, and I must leave this in the hands of the proper state and local officers.

It may seem the part of caution to proceed slowly with a campaign of eradication of the tick, and first to try it in a limited district. I do not think it best to recommend this, however, as I believe there should be no discrimination in the benefits which should follow eradication of the tick.

3. That the ranchers make it a point to rid their premises of gophers. A certain percentage of the gophers are susceptible to spotted fever, and they may play a part in the maintenance of spotted fever, the disease alternating between them and the tick.

4. That additional observations be made on the life, habits, conditions of existence, and host relationship of the woodtick which infests the Bitter Root Valley. I have made many observations bearing on these points, and am still carrying on the study. This work, however, needs to be carried on throughout the whole year and can best be done by some one who lives permanently in or near the valley. It may be possible

to enlist the services of Profesor Elrod, of Missoula, or Professor Cooley, of Bozeman, or both, in this study.

5. That additional funds be voted, if possible, for carrying to completion the scientific studies which have been undertaken. It is only by such work that further progress towards the prevention and cure of spotted fever can be made.

Chicago, January 6, 1908.

SPOTTED FEVER REPORT

NO. 2.

A Report of Investigations Carried on During the Winter of 1907-8 and the Spring and Summer of 1908

BY

H. T. RICKETTS, M. D.

LETTER OF TRANSMITTAL.

Dr. Thomas D. Tuttle.

Secretary of the Montana State Board of Health.

Helena, Montana.

Dear Sir:

I have the honor to submit herewith Spotted Fever Report No. 2, which covers practically all the work done since Report No. 1 was presented, on January 15, 1908. Some problems of a more theoretical, although fundamental, character, which have not been completed, will be dealt with at a future date. Such problems have to do with the conditions which favor or hinder the hereditary transmission of the disease in the tick, certain characteristics of the virus, experiments bearing on the cultivation of the micro-organism and its identification. These studies are now being pursued in the laboratories of the University of Chicago, together with certain therapeutic experiments with drugs.

The field work undertaken during 1908 followed logically upon the results of previous work, its main purpose being to obtain more satisfactory information concerning the habitat of the virus, and the agencies through which the disease is maintained, with the hope that the results might be of value in exterminating or controlling spotted fever. One method by which spotted fever may be maintained from year to year was described in the first report, namely, through the "inheritance" of the disease in the tick. Certain conditions suggested rather strongly that this might not be the only means, and that there may be some source in nature from which fresh ticks are being continuously infected. If there exists any other source for the virus aside from the tick, it probably is to be found in the food supply of the tick, hence in some one or more of the animals on which it feeds habitually.

The problem, therefore, was to determine which, if any, of the local animals actually suffers from spotted fever naturally. The first step in such a study is to determine which of the animals are susceptible to artificial inoculation, and then to reproduce the conditions for natural infection as closely as possible, which in this case resolves itself into experiments with

the tick. After this ground has been covered, the search for the species which actually suffer from the disease in nature may be begun, following one of two methods: First, to attempt to find animals which are infected at the time of their capture; or, two, to find animals which have had the disease and recovered from it, using the immunity test as a means of determining this point.

Only the first stage of this work was undertaken during the past season, and even this was not completed, because the time was too short and because of many difficulties which were encountered.

A very large measure of success attended the work, in spite of many obstacles, and the theory that one or more of the local animals may suffer from spotted fever naturally is now on a well established basis. That there could be as many as five susceptible species, with several others not yet studied, is a result which occasions surprise. Until the problem is carried further it would not be well to draw conclusions of too sweeping a nature. It might seem superficially that the existence of so many susceptible species would render the extermination or control of the disease all the more difficult, but this probably is not true, as I have pointed out in the report.

In order to carry on the work more satisfactorily a small laboratory, 12x14 feet, was constructed on the grounds of the Northern Pacific Hospital, which was an improvement over the tent used during the previous year. In addition a wall tent was obtained from the state militia for the purpose of housing the animals which were the subjects of experiments with the tick. The quarters for other animals were provided in a small building kindly loaned by Dr. Aylen for the purpose.

The most serious difficulty encountered in the work related to the capture of the wild animals in good physical condition. Many of them could be caught successfully only in steel traps, and as a consequence there was a large percentage of fatality among the specimens which were brought in . Those which did not die had to be kept until they had recovered from their wounds in order that they might be suitable for experiments. Most of the chipmonks and rock squirrels used were obtained by snaring, which was a very satisfactory method, all such animals being in good condition.

The experiments with the tick, particularly the "tick

cycle" experiments, were very tedious and often exasperating in that individual ticks which it was desirable to preserve for weeks, sometimes died before the experiments could be terminated, rendering repetitions necessary on many occasions.

I am especially indebted to Dr. James P. Aylen, chief surgeon of the Northern Pacific Hospital, to his assistants and others associated with the hospital, for the privileges of the hospital and its laboratory; to Prof. M. J. Elrod for the use of his laboratory and apparatus; to Mr. J. J. Moore, my assistant, on whose faithful service the results of the work depended largely; to the Northerin Express Company for the free transportation of animals and supplies, and to the physicians of the Bitter Root Valley for their uniform co-operation.

Obligations to the University of Chicago in granting me time from routine duties, and to the Memorial Institute for Infectious Diseases of Chicago, for certain financial assistance, are gratefully acknowledged.

This report is submitted as a joint report to the Montana State Board of Health, and to the Commissioners of Ravalli and Missoula Counties, in view of the financial support which came from the three sources. Respectfully Yours,

H. T. RICKETTS.

Chicago, December 12, 1908.

PART I.

THE CASES OF SPOTTED FEVER WHICH OCCURRED IN 1908.

Detailed histories of the cases will not be given, but their location may be noted as indicating the present distribution of the disease in the valley, and some points of interest in connection with them may be discussed briefly.

Case 1. Wm. C., Lo Lo Valley, about 15 miles from the mouth of the creek. Result, fatal.

Case 2. M. S., west of Victor, close to the foothills. Fatal.

Case 3. Son of Mr. P., about three miles southwest of Florence. Recovery.

Case 4. Mrs. V., Grantsdale, three miles south of Hamilton, on the east side of the Bitter Root River. Fatal.

Case 5. P. T., Lo Lo Valley, about 12 miles from Lo Lo. Recovery.

Case 6. Mrs. J. B., west and a little north of Stevensville, near the foothills. Fatal.

Case 7. Mrs. L., same location. Fatal.

Case 8. Mr. McK., five miles southwest of Hamilton. Fatal.

Case 9. Mr. K., west of Corvallis. Recovery.

Another case in the practice of Dr. Thornton of Stevensville may have been spotted fever, but the diagnosis was not verified by the inoculation of a guinea-pig. Dr. Thornton reports that he considers it spotted fever.

All the patients but one lived where the ticks are abundant, and all but two gave a history of recent tick bites; one of the latter had been bitten three weeks previously. The person concerning whom no history of tick bite could be obtained lived at Grantsdale, on the east side of the river. When I first saw her, after she had been sick for about ten days, she was irrational and could give no history. According to the data learned by the attending physicians, and the statement of her husband to me, she had not been on the infected side of the valley at all.

Hence if she was tick-bitten the ticks must have been carried to her vicinity from the west side by some other agency. Inquiry showed that her husband's horses had escaped to the west slope, and that he had brought them back ten days prior to the onset of the patient's sickness. Knowing the extent to which ticks feed on the horse, it is not improbable that some were carried to the patient's home in this way, and that one or more of them eventually bit her. As pointed out in Report No. 1, a feeding tick is often overlooked for one or more days, hence the absence of a history of tick bite does not rule out the likelihood of its occurrence in a case of spotted fever.

The attempt was made to verify the diagnosis of spotted fever in each case by injecting the blood of the patients into guinea-pigs. Such injections were made from all the cases but one; in this instance permission to draw the small quantity of blood required could not be obtained. In some instances one, and in others two animals were inoculated from each case. The experience of this year taught us, however, that two animals should be used invariably, one receiving a smaller (1-2 c. c.) and the other a larger dose (3-5 c. c.) of the patient's blood. Occasionally an inoculation fails to "take," and the chance of failure is lessened if two animals are used as described. Of the eight cases in which the inoculations were made, positive results were obtained in six. Regarding the two cases in which the tests failed, only one animal was inoculated from each patient; a different result might have been obtained had a second animal been inoculated with different dosage. The probability of this is illustrated by the result obtained with one of the other cases (Case 9.). In this instance two animals were inoculated, one with 4 c. c. and the other with 2 c. c., but only the latter, which received the smaller dose. became infected. The explanation of this is not clear; it may be an accidental result due to the presence of less virus in the larger quantity in this instance, or the larger amount of serum introduced may have killed the organisms after their injection into the peritoneal cavity of the guinea-pig. This occurrence has been encountered occasionally in the experimental work. The same experience was encountered in Boise, Idaho, earlier in the year, when of two animals inoculated only one became infected. The question naturally arises as to the likelihood of a mistake in diagnosis in those cases in which the animal inoculations did not take. This cannot be decided

except on the clinical basis, and in both instances the symptoms and course of the disease made the diagnosis reasonably certain.

In the observation of approximately thirty cases of spotted fever during the past three years it has become manifest that the character and course of the eruption are not uniform for all cases. From the standpoint of diagnosis it is important to appreciate this. The most characteristic and frequent appearance is that of larger and smaller rose-colored and pink spots which appear first on the fore-arms and legs, but are soon seen on the back, palms and soles, and eventually on the subaxillary skin, chest, abdomen and face. They are not distinctly elevated, but have a slight degree of induration which may be felt by rubbing the finger over them lightly. This increases with the duration of the spots. The number of spots increases during the disease, although they do not appear in sharply marked periodic crops, as occurs in the cutaneous lesions of smallpox. They are very persistent and gradually assume a darker and somewhat cyanotic color. When they are perfectly fresh and pink the color disappears to some extent on pressure, but as days go by the color becomes fixed. The cyanotic color is without doubt due to changes in the hemoglobin in the erythrocytes which have escaped from the vessels. In addition to this cyanotic change fresh minute hemorrhages commonly, but not always, take place, first in the apices of the old spots and apparently also in places which hitherto had not been involved. When these first occur they are dark red and soon become bluish black, and from the fact that they are small, discrete and often thickly set, the term "turkey egg appearance" has been used to describe them. These minute hemorrhages first appear over the elbows, shoulders, scapulae and buttocks. One patient passed through the disease and recovered last spring without showing this "turkey egg" rash. In a small percentage of the cases the hemorrhages into the skin are even more extensive than just described. Confluent hemorrhagic areas as large as the hand, with processes which anastomose with neighboring patches, may cover the whole body.

Contrary to the usual appearance, in three of the cases occurring last spring the forearms and legs were almost entirely devoid of either roseolar or hemorrhagic spots, although they were numerous on other parts of the body (Cases 1, 2 and

6). In another also no roseolar eruption was recognized at all, but it appeared in the form of minute hemorrhages in the skin over the elbows, shoulders and buttocks on the fourth day of sickness.

It is possible that the serum which was used last spring altered the appearance of the rash in some cases. Prophylactic injections were given to a number of individuals, and in two of these a serum rash resulted which assumed a hemorrhagic appearance; others showed no such reaction.

A SERUM DERIVED FROM THE HORSE.

In the report of last year I called attention to the facts that one attack of spotted fever in the experiment animals results in strong and sustained immunity to further attempts at infection, and that the serum of the immune guinea-pig when injected into a normal guinea-pig protects the latter against artificial inoculation for 30 to 40 days. This point is also referred to in the present report in relation to work with immunity in the gopher. Work of the past year has shown also that the serum of man after recovery contains similar protective antibodies.

It was also mentioned in the previous report that the serum of the immune guinea-pig has a distinct curative effect on the experimental disease provided it is given on the first or second day of fever. The hope was expressed that it might be possible to produce immunity in a larger animal so that serum might be available for therapeutic trial.

Assisted by Mr. P. G. Heinemann and Dr. William M. Chowning I made two prior attempts to infect the horse in the spring of 1907. It is probable that one of these attempts was successful, although this was not proved at the time. The animal* received subcutaneously 65 c. c. of infected blood from guniea-pigs which had been inoculated with a strain recently obtained from man. At the end of the second day the temperature of the horse rose to 102.4, on the third day it was 104.3 (A. M.) and 105.6 (P.M.); fourth day, 103.2 (P. M.), and from this time it returned rapidly to normal. On the day of highest fever the animal appeared to be severely ill, but during the next few days recovered, except for great stiffness of the joints, which improved only after a number of days. No cuta-

(* This animal was given for the purpose by the Big Blackfoot Milling Company.)

neous phenomena could be found. It was the purpose to inoculate guinea-pigs with the blood of the horse, but its fever going down unexpectedly early (marked fever lasting for only 24 hours), it was thought best to repeat the experiment with another animal.

The experiment with the second horse was entirely un satisfactory. It received 10-11 c. c. of blood from a human patient (Payne) who presumbaly had spotted fever. However, two guinea-pigs which were inoculated with this patient's blood failed to develop the disease, hence it seemed probable that Payne either suffered from some other infection, or, if he had spotted fever, that he was rceovering from it at the time his blood was taken, and that the latter consequently was free from micro-organisms. About three weeks later 80-84 c. c. of infected blood from the monkey were injected into the same horse, and this also was without apparent effect. This second failure may have had any one of several causes: Assuming that Payne suffered from spotted fever, and that he had not recovered at the time his blood was drawn, the injection might have caused a mild attack in the horse, accompanied by no distinct fever, with the result that the animal had a marked immunity thereafter; or, on the other hand, if Payne had recovered from spotted fever his blood, now immune and endowed with protective powers, may have protected the horse against the virulent blood of the monkey given in the second injection. These considerations were not appreciated until later, as the question of immunity in spotted fever had not yet been studied. His resistance may have been high naturally, or one might assume that he had already been infected in nature since the animal was raised in Montana (Flathead Reservation), but inasmuch as resistent horses were encountered in Chicago later, such an assumption would be unnecessary to explain his resistence.

Subsequently, in the winter of 1907-8 infection of three additional horses was attempted on the farm of the Memorial Institute for Infectious Diseases, near Chicago. The blood of the infected guinea-pig (third day of fever) was used for all three animals and the injections were made into the peritoneal caviety instead of subcutaneously as heretofore.

On January 31, 1908, horse 3 received intraperitoneally 110 c. c. of defibrinated blood from infected guinea-pigs. This

blood represented the "Bradley" strain of the virus which, at this time had been cultivated in the guinea-pig for one year and a half. The horse had previously been used for immunization with diphtheria toxin, but had been discarded as a poor producer of antitoxin.

The temperature of horse 3 was as follows:

	A. M.	P. M.
Jan. 31	....	101.7
Feb. 1	99.1	99.5
Feb. 2	100.8	103.
Feb. 3	103.6	102.2
Feb. 4	101.9	102.7
Feb. 5	103.4	102.6
Feb. 6	103.	102.
Feb. 7	102.2	102.7
Feb. 8	102.5	103.
Feb. 9	102.	101.5
Feb. 10	101.	100.7
Feb. 11	100.5	99.5
Feb. 12	100.	....
Recovery.		

It is seen from this that there were two rises in temperature, a primary rise appearing on the afternoon of February 2, two days after inoculation, and a secondary, which began two days later, or four days after inoculation.

On the third day when the temperature was 103.6, blood was drawn for the purpose of inoculating animals, in order to determine whether the virus was circulating in the blood of the horse. A guinea-pig received 3 c. c., and a rabbit 10 c. c., both intraperitoneally, but neither developed spotted fever. An immunity test was performed on the guinea-pig 24 days later, with the result that he then contracted spotted fever, which was conclusive proof that he had not been infected by the blood of the horse in the first instance.

It seems probable, therefore, that the short primary fever was due to intoxication by the foreign blood injected rather than to generalized infection by the virus of spotted fever.

The second rise of temperature was of longer duration, approximately six days. On Feb. 6, seven days after inoculation and two days after the beginning of the secondary fever, blood was again drawn for the inoculation of two guinea-pigs. One of these received 1 c. c. and the other 5 c. c. of the blood intraperitoneally. The former after an incubation period of four days developed a high fever which persisted until its death, 11 days later. It presented the swollen and gangrenous scotum, and the gangrenous ears and feet which are so characteristic of spotted fever in the guinea-pig, and the conditions of the organs at autopsy were also typical for the disease. Culture

experiments showed that no other micro-organisms were present to account for the sickness and death of the animal. In order to render it more certain that the guinea-pig had spotted fever, 3 c. c. of its blood drawn on the third day of fever were injected into another healthy guinea-pig. This animal also developed the disease just as typically as the first one.

Strangely the guinea-pig which received 5 c. c. of the blood of the horse did not contract spotted fever. It has, however, been the experience many times that a small dose often will infect in cases in which a larger dose fails to do so. This is referred to elsewhere in this report.

Regardless of the negative outcome in the second guinea-pig, the result in the first leaves no room to doubt the infection of the horse with spotted fever.

If the serum of this horse should be used for therapeutic purposes, it was of the greatest importance to determine whether or not it had recovered from spotted fever, or whether the organisms were still in the blood. For this purpose blood was again drawn on the 22nd of February, ten days after the subsidence of fever, 1 c. c. being injected into one guinea-pig, 2 into another and 5 into a third. None of these animals became sick. Some weeks later, after the passive immunity conferred by the serum should have disappeared, all three were given immunity tests, and all contracted spotted fever, corroborating the fact that they had not been infected by the blood of the horse in the first instance. This seems to prove with sufficient clearness that the virus of spotted fever no longer circulated in the blood of the horse, and that his serum could be used with safety for therapeutic purposes.

Two other attempts to infect horses were made, but both failed. Horse 4 received 80 c. c. of infected blood from the guinea-pig drawn on the third day of fever. The animal showed a slight rise in temperature beginning on the third day after its inoculation and persisting for three days. Blood drawn on the sixth and also on the ninth day after inoculation failed to produce spotted fever in the guinea-pig when given in doses of 1, 2 and 5 c. c. Later it was found that the serum had no protective power for the guineau-pig even when given in doses of 5 c. c. Hence horse 4 did not become infected.

Horse 5 received intraperitoneally 85-90 c. c. of virus from the guinea-pig, to which was added an emulsion of the livers and

spleens of the guinea-pigs, these organs being fairly rich in virus. Horse 5 had no more than a degree and a half of fever at any time, its blood contained no virus as demonstrated by inoculations into the guinea-pig, and its blood later was not protective for the guinea-pig. Hence horse 5 also did not become infected.

The best that can be done in the way of standardizing such a serum is to determine its protective power against a fixed quantity of the virus. While there is some difficulty about measuring the quality of virus in infected blood, this can be done in a fairly satisfactory way in terms of the minimum infective dose of the blood for the guinea-pig, always using blood taken on the third day of fever. In a great many experiments, 0.01 c. c. of virus has always been infective for the guinea-pig, and not infrequently 0.001 c. c. is infective. The minimum infective dose therefore lies at some point between 0.001 c. c. and 0.01 c. c. In determining the protective power of a serum it has seemed best to test it against 1 c. c. of such infected blood, a quantity which represents at least 100 pathogenic doses of the virus.

The serum of the guinea-pig which has recovered protects against 1 c. c. of virus, in quantities of from 0.1 c. c. to 0.2 or 0.3 c. c., the power varying in the serum of different animals.

Repeated tests of the protective power of the serum of horse 3 have shown that its value lies close to that usually found in the serum of the immune guinea-pig, although it is a little weaker. One typical test may be cited. Three guinea-pigs (1233, 1234, 1235) received each 1 c. c. of virus to which were added, immediately before injection, varying quantities of the serum (0.1, 0.25 and 0.5 c. c.), the injections being intraperitoneal. The animal which received 0.1 c. c. of serum had moderate fever for five days; that receiving 0.25 c. c. of serum had four days of low fever; that receiving 0.5 c. c. of serum had no fever at all. In the way of a control, it has been found that 5.0 c. c. of serum from the normal horse show absolutely no protective power against 1 c. c. of virus (guinea-pig 1158), and 1 c. c. gave no protection against 0.05 c. c. of virus.

In doses of 5 c. c. the serum of horse 3 was shown to have no injurious effect on guinea-pigs.

USE OF THE SERUM IN MAN DURING 1908.

In view of the protective power which the serum of horse 3 showed and since it appeared harmless when injected into guinea-pigs in comparatively large doses, it was decided to recommend its use in the treatment of spotted fever during the spring of 1908, and for prophylaxis in the case of those who might apply.

A priori, there was not a great deal to hope for the therapeutic effect of the serum for the following reasons: Its "neutralizing" power for the virus, although fairly strong, is greatly lower than that of diphtheria anti-toxin for its toxin, if one could make a comparison in these two cases. One unit of diphtheria anti-toxin neutralizes 100 fatal doses of the toxin, and one cubic centimeter of the anti-toxin serum commonly contains 500 units, capable of neutralizing 50,000 fatal doses of the toxin. This comparison is hardly proper, however, since the nature of the serum against spotted fever is not known. In experiments with the guinea-pig the serum showed curative powers only when given on the first and second days of fever, and inasmuch as human patients do not commonly call a physician until they have been sick for more than one or two days, the serum could not usually be given at the favorable moment. Also the quantity of the serum which would be required to produce a curative effect in man, computed according to the comparative weights of man and the guinea-pig, would be unreasonably large. It was not lost sight of, also, that the chance of successful therapy depends on the character of the serum, i. e., whether it is bactericidal or antitoxic in nature. There is no means of determining this point positively until the organism can be manipulated in artificial cultures. If it is purely bactericidal numerous analogies suggest very strongly that it could not be an effective curative agent, although it might still have a high prophylactic value.

Regardless of this unfavorable outlook its trial was justifiable, and indeed mandatory, on account of the hopeless severity of the disease in 80 per cent of the cases. It was barely possible that the serum, even when given after the second day, might increase resistence to such a degree that some individuals would recover who otherwise would succumb.

Manifestly the question of dosage was one which could be

determined only by trial, hence the treatment was not uniform for all cases.

THE INDIVIDUAL CASES.

In describing the cases, numbers are used which refer to the list given in the section on "The Cases of 1908."

Case 1. Adult man. Had been sick for six or seven days when first seen by Dr. Pease. Patient did not call a physician prior to this time. The eruption was typical for spotted fever except for its scant occurrence on the forearms and legs. Toward the end of his sickness minute hemorrhages appeared on the arms, deltoid region, back and also on the palate. The diagnosis was further established by the positive outcome of inoculation of his blood into two guinea-pigs.

He received in all about 60 c. c. of serum, 20 c. c. being given on the sixth day of sickness, 20 c. c. on the seventh and 20 c. c. on the eighth, all subcutaneously. The temperature fell somewhat following the first inspection, but it rose after the second, and the third seemed to produce no effect. No improvement in his general appearance, or subjective condition, followed the injections. He died on the ninth day after serious illness began.

Case 2. Adult man. Was first seen on the fourth day of sickness by Dr. Hanbridge. His last tick bite was five to seven days before the onset of sickness. Says the tick had a "striped" back, hence it probably was a male. On the fifth day of sickness a profuse roseolar eruption was present on the skin of the abdomen, back and upper arms; none on the forearms, wrists, legs or ankles. The spots disappeared on pressure. On the seventh day petechiae appeared in the skin of the shoulders, scapulae and buttocks; none on the wrists and forearms. The fever ranged between 101 and 104.6, and was somewhat irregular, partly from the influence of cold baths. The diagnosis was rendered more positive by the infection of two guinea-pigs which were injected with his blood. The patient received in all 100 c. c. of serum as follows: 20 c. c. on the fourth day of sickness, 20 c. c. on the fifth day, 20 c. c. on the sixth day, 40 c. c. on the seventh day in two injections. All injections were subcutaneous. No modifications in the temperature, general condition in the patient or his subjective feelings followed as a consequence of the injections. Death occurred on the ninth day of illness.

Case 3. Boy. Age between seven and eight years. Case appeared mild from the beginning. The eruption and course of fever were typical. Diagnosis was not established by the inoculation of guinea-pigs, inasmuch as permission to draw blood could not be obtained. Repeated injections of the serum subcutaneously in doses of 8 to 18 c. c. were given by the physician, Dr. Fessler, a total of 138 c. c. being administered. The patient recovered. In regard to the recovery of this patient it is to be noted that the infection seemed mild from the beginning, and that the percentage of recoveries is higher in children than in adults. The duration of the disease apparently was not shortened.

Case 4. Adult woman. Patient was not seen until she had had the eruption for nearly a week, and she was semi-conscious when first seen. The physician, Dr. C. R. Thornton, stated that sickness began with what appeared to be facial erysicpelas. Later she presented a foul discharge from the vagina, and a uterine infection was suspected, although the eruption appeared like that of spotted fever. This was so much in doubt, and the patient was virtually moribund, hence no serum was given. Cultures were made from the blood and guinea-pigs were inoculated. It was anticipated that the streptococcus would be inoculated from the blood. This was not the case, however. The cultures remained sterile and, moreover, the guinea-pigs developed spotted fever, which rendered the diagnosis certain. She died two days later. Doubt as to the condition in this case was all the more justified, since she lived on the east side of the river, and gave no history of exposure to tick bites.

Case 5. Adult male. Seen on the third day of sickness by Dr. E. E. Dodds. Bitten by ticks a great many times during the spring. A diffuse, but rather sparse, roseolar eruption was present in the skin of the abdomen, back, arms, forearms and a few spots on the palms. Spots are slightly indurated on deep pressure; not noticeably elevated. Lymph glands enlarged. At first there was no tenderness of the skin, although there was some general soreness; but later this was a pronounced symptom. Patient perfectly intelligent, but inclined to be soporose. The number of spots increased continuously, and on the sixth day of sickness petechial hemorrhages appeared on the buttocks and shoulders, although they were not extensive. All the spots eventually became of a cyanotic color. On the 10th day the

spleen was found enlarged on percussion, but it was barely palpable. In the third week its size increased, and on the 20th day it could be felt two inches below the costal arch on deep inspiration. It was rather firm. The patient's fever lasted for three weeks, and convalescence was slow, requiring several weeks.

These clinical features are emphasized because the diagnosis of spotted fever rests on them entirely. Inoculation of the patient's blood was made into one guinea-pig, but it did not develop fever. Perhaps a positive result would have been obtained if an additional animal had been given a different dose, or a second inoculation made later.

The patient received in all 120 c. c. of serum, given subcutaneously as follows: 40 c. c. on the third day of fever in two injections, 40 c. c. on the fourth day; 20 c. c. on the fifth and 20 c. c. on the sixth day. At the time the first injection was given, and for some hours later, the patient's temperature was between 104 and 104.5. On the next day it went no higher than 102.8, and indeed during the remainder of his sickness it was a low temperature, rarely reaching 103. This effect was no doubt due in part to frequent cold sponges.

Insofar as the effect of the serum is concerned this case is difficult to interpret. He appeared to be very sick when he entered the hospital, and his condition improved greatly after the first two injections of serum were given. The question naturally arises as to whether a curative effect of the serum is compatible with the continuation of the disease for two weeks after the last dose was given. Theoretically, it is entirely compatible, although it is manifest that there would be less difficulty in recognizing a curative effect of the serum if its injection were followed by a sudden subsidence of symptoms, such as antitoxin causes in diphtheria.

Case 6. Adult woman. Called a physician (Dr. W. T. Thornton) late in the disease, probably the fifth or sixth day. At that time she had a hemorrhagic ereuption, and her blood produced fatal fever in the guinea-pig. She received in all 80 or 100 c. c. of the serum subcutaneously, without any visible modification of the disease. She died on the tenth day.

Case 7. There is some doubt about the diagnosis in this case although it was quite typical clinically for spotted fever. A few weeks before her sickness began she was bitten by one or

more ticks and received a prophylactic injection of the serum. When her physician, Dr. W. T. Thornton, saw her, at the beginning of her illness, she had a moderate roseolar eruption which showed slight induration on gentle pressure. Following a second injection of serum at this time the spots increased in number rapidly, and there was naturally a question as to whether the eruption was due to her infection or whether it was a serum rash, at least in part. This cannot be decided. Two other points contributed to uncertainty in the diagnosis. In the first place a guinea-pig inoculated with her blood did not develop spotted fever, and later proved susceptible on reinoculation. In the next place, a blood culture in bouillon yielded an organism which resembled the typhoid bacillus, but as positive means of identification were not at hand this could not be determined and the culture was lost later. Neither of these points absolutely precludes spotted fever, since as stated earlier, a single inoculation of the guinea-pig sometimes fails even in cases of undoubted spotted fever. The cultivation of the bacillus possibly was due to an error in technique.

In all she received over 300 c. c. of serum, as stated by the physician, the first injection being given when she had been sick about 48 hours. So far as could be determined the infection was not influenced thereby, and she died on the 19th day.

Case 8. Adult male. Typical for spotted fever in all respects. Blood cultures gave no growth, and two guinea-pigs which were inoculated with patient's blood died of spotted fever, one receiving 2 c. c. and the other 4 c. c. The eruption was typical in all respects.

Injections of serum were begun on about the sixth day of sickness, and continued until the fifteenth day. One injection was given daily, usually in a dose of 20 c. c., but on two days 40 c. c. were given. The serum appeared to exert no influence on the infection, unless it prolonged the course. He died on the 26th day, which is an unusually long course. Pulmonary complications were reported by the physician, Dr. McGrath, at the time of death. In all 220 c. c. of serum were given.

Case 9. Adult man. First seen on the fourth day of sickness by Dr. C. R. Thornton. More or less generalized roseolar eruption which extended and eventually became petechial. On the sixth day two guinea-pigs were inoculated with the patient's

blood, one with 4 and the other with 2 c. c. Only one of these contracted spotted fever, but this was sufficient to prove the infection. A culture from the patient's blood was sterile. The first injection of serum, on the sixth day, was given intravenously, dose 20 c. c. I have not learned the total quantity given later by the physician. No immediate improvement followed its use. The fever throughout was moderate, at no time being higher than 103.8. The patient recovered after being sick for 17 to 20 days. Convalescence required some weeks.

The following table shows the essential data of the cases in so far as they bear on serum therapy:

Case	Day on Which 1st Injection Was Given	Total Quantity	Interval of Administration	Method	Duration of Disease	Result	Diagnosis	Severity
1	Sixth or seventh	60 c. c.	6th-8th days	Subcut.	Nine days	Death	Verified.	Severe
2	Fourth	100 c. c.	4th-7th days	Subcut.	Nine days	Death	Verified.	Severe
3	Third (?)	138 c. c.	During entire sickness	Subcut.	3 to 4 weeks	Recovery	Not verified	Moderately severe.
4	No serum given	....	....	....	....	Death	Verified.	....
5	Third	120 c. c.	3rd-6th days	Subcut.	Three weeks	Recovery	Not verified	Moderately severe.
6	Fifth or sixth	80-100 c.c	5th to 8th, probably	Subcut.	Ten days	Death	Verified.	Severe
7	Third	300 c. c+	During entire sickness	First intravenous, others subcutan.	Nineteen days	Death	Not verified	Severe
8	Fourth	220 c. c.	5th to 15th	Subcut.	26 days	Death	Verified.	Severe
9	Sixth	...(?)...	.....(?)....	First intravenous others subcutan.	3 to 4 weeks	Recovery	Verified.	Severe

It is unsatisfactory to attempt to interpret the effect of the serum on the basis of the percentage of mortality. The diagnosis was confirmed by animal inoculations in only six cases of the nine, and the cases are too few in number. The mortality among those the infection of which was proved by transfers to the guinea-pig and by the negative outcome of cultures, was 88 per cent; among the total of nine cases 66 2-3 per cent. The latter is lower than the customary death rate, and probably more nearly correct than the former.

It is to be recognized that the quantities given and the routes of administration employed were not uniform for all cases, nor were they all obtained equally early for treatment. In three cases treatment was begun on the third day, and two recovered; the two on which treatment was begun on the fourth day died; of those which were treated later two died and one recovered.

The natural severity of the infection in the different cases also should be taken into account, and for this one must rely on the duration of the disease whether ending in recovery or death, and the general condition of the patient during the major part of the course. If hemorrhages appear as early as the sixth or seventh day, it seems to indicate virulent infection, or perhaps a condition not to be differentiated from this, namely, poor resistence on the part of the patient. Three of the treated and one of the untreated cases evidently were severe from the beginning, and all died. Two of the three which recovered appeared to have moderately severe infections, judging from their condition early in the disease, although both eventually were very sick. The third patient who recovered appeared to be more highly intoxicated from the beginning.

Although the results of this attempt at serum therapy are by no means satisfactory, it would seem that the serum should not be discarded without further trial. It has shown itself to be harmless even when given in very large doses, and since it actually does contain curative and protective antidotes, it should be used further with such modifications as past experience suggests. In particular early administration it is absolutely demanded; larger quantities should be given at the initial injection and the intravenous route should be utilized with the proper precautions. Two cases last year received 20 c. c. intravenously each without unfavorable manifestations.

Injections of 20 c. c. each, with prophylactic intent, were given to five persons who applied for them, and who had recently been bitten by ticks in infected localities. No inference can be drawn concerning protection in these cases, as it was unknown whether or not the ticks were infected. In view of the fact that only a comparatively small number of ticks in nature appear to be infected, prophylactic injections would need to be carried on with a large series of individuals before their merit would be known.

Serum was also injected into two persons who were ill, who had been bitten by ticks, and in whom spotted fever was suspected. They recovered very promptly, which argues quite positively against their infection with spotted fever, when we consider the results obtained with proved cases of the disease In the two instances referred to inoculations into the guinea-pig failed to produce spotted fever, two animals being inoculated from one of the cases.

THE SPOTTED FEVER OF IDAHO.

It seems justifiable to include in this report a brief account of some investigations of the spotted fever of Idaho, which I carried on during the past season, the work being supported by the American Medical Association.

The mortality of the disease in Idaho is constantly so low, not far from 5 per cent, and that of Montana is so much higher, that the question may well arise as to whether or not they are the same disease.

That they do represent the same disease is shown by the following observations: The spotted fever of Idaho may be reproduced in the guinea-pig by the inoculation of the blood of patients, and in these animals the disease is identical in all respects with that of Montana. Guinea-pigs which have recovered from the Montana disease are thereafter immune to the Idaho disease, and, similarly, those which have recovered from the Idaho disease are immune to that which is found in Montana.

A very important observation concerns the tick of Idaho, which transmits spotted fever. This was found to be a different species from the spotted fever tick of the Bitter Root Valley, although it belongs to the same genus, Dermacentor. Its specific identification has not been made. This observation may serve to explain the difference in the virulence of spotted fever in the

two places; that is to say, the virulence of the micro-organism may be attenuated in the Idaho tick and enhanced in the Montana tick. I have found none of the Idaho ticks in the Bitter Root Valley.

In speaking of the spotted fever tick of Idaho, I do not mean to state that the tick mentioned is the only one in Idaho which will transmit spotted fever. Other species were observed there, particularly one which resembles Dermacentor albipictus, but the one mentioned was the only one experimented with. I found none of the Montana spotted fever ticks in the districts visited, although they may occur in other portions of the state.

Another possible factor in explaining the difference in virulence between the Idaho and Montana diseases may be a difference in the animals which serve as hosts for the infection. Many of the animals are the same in both places, but there is at least one ground squirrel in Southern Idaho not seen in the Bitter Root Valley.

Experiments are under way to determine the influence of the two species of tick on the virulence of the infection.

The spotted fever of Idaho is of importance to Montana chiefly because of the posibility that it may have been introduced from Idaho into Montana in the first place, and in the event that it is exterminated from Montana, it may again be introduced from Idaho. This is purely hypothetical, and the converse of the proposition may be true, namely, that the disease existed in Montana prior to its occurrence in Idaho. As against the latter conclusion, however, are the facts that the disease has been known in Idaho for a much longer period than in Montana, and that it covers a greeat deal more territory in Idaho than it does in Montana. It would seem to require time for the disease to obtain such an extensive distribution as it has in Idaho.

Part II.

RECAPITULATION.

In order that the material may be presented in a more consecutive form the results obtained prior to the spring of 1908 may be summarized somewhat briefly, insofar as they bear on the life history of the disease. This material has already been presented in more detailed form in Report No. 1.

The proof is now of a conclusive character that man is infected with spotted fever through the bite of the "wood-tick," and under natural conditions he is not exposed to infection by other means, such as through wounds.

The following, quoted from Report No. 1, summarizes the points which prove the correctness of the tick theory: "First, the disease is limited to the season of activity of the adult male and female ticks, which, in contrast to the larvae and nymphs, feed readily on man. Second, in practically all cases of spotted fever it is possible to obtain the history of a recent tick bite, and from experiments performed on animals with the tick, it has been learned that the period between the tick bite and the onset of fever in the animal, corresponds closely with this period as observed in man. Third, infected ticks exist in nature in the so-called infected districts. Fourth, the relation of the virus of spotted fever to the tick is very intimate in its character, a fact which is shown by the ability of the female to infect her young through her eggs, and also by the fact that either the larva or nymph may acquire the disease by biting sick animals and retain it during molting and the subsequent active stages. In other words, the relation of the virus to the tick is of a very special character and it may exist in the tick for a very long period, apparently without doing the tick great injury."

"The disease cannot be acquired through the digestive tract, nor through ordinary abrasions of the skin, as shown by animal experiments, whereas the tick becomes infected readily, retains the disease a long time, and when once infected will produce the

disease in susceptible animals as often as it can be induced to bite. The male as well as the female will acquire and transmit the disease.

The significance of hereditary transmission of the disease will be discussed below.

In man and in the susceptible animals so far studied, spotted fever is a generalized infection, with large quantities of the virus in the circulating blood, which renders it easy for ticks to become infected when feeding on sick animals. This was found to be true also of the five species studied during 1908, as will appear later.

In all the animals which have been studied, also, spotted fever appears to be an acute infection, and it is doubtful if the virus remains in the body of animals after recovery has occurred. This is certainly true of the guinea-pig and monkey, and the work of 1903 indicates that the same is true of the other susceptible species studied. The theoretical importance of this lies in this consideration: If certain animals which serve as hosts for the tick suffer from a chronic form of spotted fever, the opportunities for the infection of the tick are greatly increased thereby, whereas if the disease is acute in all animals the opportunity for tick infection is very much lessened.

The different stages through which the tick passes, from the egg to the adult, were described in the first report, and need not be repeated here. It is sufficient to note that the adult stage is limited to the spring, and that the remainder of he year is passed in the egg, larval and nymphal stages, the larvae and nymphs feeding on animals other than man.

That part of the life history of the tick which is now of the most practical importance, concerns the source of its food and the different animals on which it feeds during all three of its active stages. It has long been concluded that ticks feed exclusively on animals, and I have found no facts which point against this belief. This is a point of the utmost importance, for the source from which the tick becomes infected in nature, probably coincides with the source of its food, and if it feeds exclusively on animals, it must derive its infection from animals. Certain it is that ticks which do not reach animal hosts do not survive long in nature; propagation of the tick is utterly impossible without a sufficient supply of blood or serum from animals.

Prior to 1908 I had found ticks in great abundance on cattle

and horses; in a few instances on gophers, and from reports obtained from reliable sources it seemed probable that it feeds on all available warm blooded animals. The observations of the past season, as stated later, go to confirm this.

CONCERNING THE SOURCE OF INFECTION FOR TICKS AND THE MEANS BY WHICH SPOTTED FEVER IS KEPT ALIVE FROM YEAR TO YEAR.

Inasmuch as spotted fever in man is limited to the months of spring it is necessary to find the whereabouts of the virus at other times of the year, if possible, and to attempt to discover its natural habitat. The limitation of spotted fever in man to the months of spring has already been explained on the basis of the tick theory, inasmuch as this is the season of the adult stage of the tick, and it does not feed on man except in rare instances, during its larval and nymphal stages, which prevail at other periods of the year.

In considering the natural habitat of the virus, one might assume in the first place that it resides naturally in the tick, i. e., in its salivary glands, just as certain micro-organisms are to be found with almost unfailing constancy in the saliva of man. Positive proof has been obtained however that this is not the case. The first point in evidence consists of the fact that very many people in the infected districts are bitten by ticks every year without contracting the disease following tick bites. The second point is experimental, in that hundreds of ticks from infected districts were tested on guinea-pigs during 1907, and a small percentage were found to be infected. The susceptibility of the guinea-pig is so high that the result must be taken as conclusive evidence on this point.

It is therefore necessary to conclude that the tick acquires its infection from some outside source, and as stated above this source in all probability coincides with its ordinary food supply, namely, the blood of some animal on which it feeds habitually or on occasions.

Dropping, for the moment, the question of the original source of the virus for the tick, we may review at least one means by which the disease may be kept alive from one year to the next. This relates to its "hereditary" transmission in the tick.

As described in Report No. 1, the possibility of hereditary

transmission in the tick was proved in 1907, in that it occurred in two out of twenty-eight experiments. A still higher percentage (about 50 per cent) was obtained in a series of experiments performed in Chicago during the winter of 1907-1908. There are some conditions which may explain in part this great difference between the results of the experiments in Montana and in Chicago. In the Montana experiments all the females were allowed to feed on infected guinea-pigs for a much longer time than is required for their infection, and indeed they were matured on nothing but infected guinea-pigs. The infectivity of the different individuals was not tested, however, and it is possible that a certain percentage of them did not become infected in the first place, or if they did that they did not retain the infection. Other experience has shown that of a large number of ticks which have had equal opportunity for infection, all the individuals may not acquire the disease or may not retain it; this is quite a small percentage however. In the Chicago series, however, all the females were proved to be infected before oviposition bgan, eighteen experiments being carried through completely. Of the eighteen, hereditary transmission could be demonstrated in only nine the, transmission being determined by permitting the larvae to feed on normal guinea-pigs. The greater percentage of hereditary transmission in the Chicago experiments may also have depended on the more favorable conditions under which the ticks were kept. In Montana the ticks and their eggs were kept at outdoor temperature, with rather wide differences between the temperature of the day and the night, a condition which retarded the hatching of the eggs and which may have had a deleterious effect on the virus as it existed in the eggs. Its culture material, so to say, may have been exhausted by a prolonged life in the egg. In Montana, also, the eggs were exposed to a greater degree of light than prevailed in the laboratory in Chicago, and it is possible that light may influence the viability of the organism. Some experiments that are now under way do indeed show that the virus lives longer in the dark than in the light. The moisture in the air in Montana also was inconstant, whereas in Chicago it was kept fairly constant. It is important to note, in regard to these experiments, that under the best artificial conditions, hereditary transmission occurred in only 50 per cent of the experiments,

whereas in the more natural conditions which prevailed in Montana it occurred in only 7 per cent.

In view of the fact that hereditary transmission of the disease does take place in the tick in a certain percentage of the cases, the question naturally arises as to whether this may not be the sole mean by which the infection is kept alive from one year to the next. In case this is assumed we shall have to leave unanswered the query: Where did the ticks get the disease in the first place? simply taking it for granted that a certain number of them did acquire it from some natural source, which in the course of time disappeared.

The history of some infected ticks which I have had in my laboratory for a year and a half would seem, on superficial examination, to lend some support to this possiblity. In the summer of 1907 a large number of adult ticks collected from the Bitter Root Valley were infected by feeding on diseased guinea-pigs. The offspring of some of these were infected and to this number others were added later, the offspring of which also were infected. Since that time they have passed through two generations and during each larval, nymphal and adult stage some of them have always been infected. Thus we may say that the disease has been kept alive in a hereditary manner into the third generation. In suite of this, however, the result does not prove that spotted fever may be kept alie in the tick through inheritance alone, because of the oportunities which were given for reinfection of the ticks at every feeding. They were "brought up" exclusively on guinea-pigs and the latter invariably became infected when the ticks of this group were placed with them, thus affording opportunity for the infection of individuals which had escaped the disease prior to this time. It is probable that not all the young of an infected female are borne with the disease, but when the whole group feeds on the guinea-pig, the larvae which are infected convey the disease to the animal, from which the uninfected larvae may then acquire the virus. Similarly, in the nymphal stage, if any nymphs have reached this point without being infected, they may become so after the infected individuals have transferred the disease to the guinea-pig. When the ticks have reached the adult stage, a certain number of them have been tested individually, and it has been found that a very large percentage of them are infected, whereas a very small number are not. The point which these statements

are intended to illustrate is the following: that the number of infected adults which are obtained in the experiments as performed, cannot be considered as identical with the number which would be obtained if the opportunity for reinfecting them as larvae and nymphs had not been present. The results do not illustrate uncomplicated "hereditary" maintenance.

It may never be possible to devise satisfactory experiments to prove whether or not hereditary transmission would take place indefinitely in the absence of opportunity for reinfection. There are two ways in which such experiments might be conducted, without any promise of either being successful. After the initial infection of the adults, the feeding of the offspring in their subsequent stages could be conducted either on animals which had recovered from spotted fever, hence not susceptible to the disease further, or on animals which are naturally immune to the disease. Before this could be undertaken, however, preliminary experiments would be required to determine the effect on the virus as it exists in the tick, when the latter feeds on animals which have either the natural or acquired immunity to the disease. It is conceivable that in feeding on such animals the virus in the ticks would be destroyed. It would also need to be determined whether the animals which show an apparent natural immunity are really immune, or whether they may suffer from a mild general infection sufficient to infect other ticks, but not sufficient to cause severe symptoms in the animals. It is thus seen that the positive determination of this point is fraught with many difficulties, and perhaps is not susceptible to positive determination.

The best reason for believing that "hereditary" transmission alone cannot be resonsible for the maintenance of the disease lies in the fact that it probably occurs in less than 50 per cent of the cases under natural conditions. As stated, under the most favorable conditions in the laboratory, it occurred in 50 per cent of the experiments, and those in Montana indicate that under more natural conditions it is much less than this. When one places the question on the basis of the following considerations, it would seem that the result would be the natural death of the disease in the course of time if the percentage of transmission is no greater than 50 per cent: Since the number of ticks in the valley appears not to be on the increase, the present number would be maintained if, for every female of the past

season, two ticks should reach full maturity the following season, i. e., a male and a female. It does not work out in just this way, for many hundreds of females die without laying eggs; but over a long course of time the species would be maintained at current numbers, under such an average condition. If this supposition is correct, and the percentage of hereditary transmission is not more than 50 per cent, the number of infected ticks each year should be only half of the number which existed the preceding year. Therefore, on this basis, the number of infected ticks in nature should become exceedingly small in the course of a few years, and in a short period they would be infinitesimally small, with the natural death of spotetd fever as a consequence.

The possibility that man might be the sole source from which the ticks become infected was considered somewhat briefly in report No. 1. This question arises naturally, when we consider that this condition is supposed to exist in relation to malaria or yellow fever, namely, that man is the only source from which the corresponding mosquitoes derive their infections.

In case this were true of spotted fever it would be necessary to assume that man first derived his infection from some unknown outside source, or that he was first infected by a tick which had contracted the disease accidentally from some unknown outside source. In order that he might then play a part in keeping the disease alive it would be necessary for one of the two following procedures to occur: First, other ticks (females) which were hitherto uninfected, might feed on the patient during his course of fever, become infected thereby, escape observation by the patient or his friends, drop off, subsequently become attached to another animal, become impregnated if this had not occurred previously, mature, drop off, lay eggs, and pass the disease to its young through its eggs. If such ticks were males we have no reason to believe that they would play an essential part in the occurrence of infected ticks during the next season. Second, the previously uninfected females which might become infected from the patient, might mature on the patient until they were ready to lay eggs, in case they had been previously impregnated. They might drop off, lay eggs, and be responsible for the appearance of infected ticks the next year, by means of "hereditary" transmission.

Concerning both of these points the tick which produced the infection in the first instance has no further relationship to the maintenance of the disease, except that it has received a greater or less degree of nourishment from the patient. The requirements is that other ticks which may feed on the patient subsequent to the development of generalized infection, become infected, escape and subsequently lay eggs.

Taking the second point first, it is the height of improbability ahat a female tick could spend the six to ten days required for maturing and reach such a large size without eventually being discovered and destroyed. This is particularly true, since such secondary ticks, in order to become infected, would need to feed at a time when the disease is generalized in the patient, i. e., when he is ill and subjected to inspection by his friends and physician.

Concerning the first point, namely, that the secondary ticks might become infected, escape from the patient and eventually mature on some other animal, escape again and lay their eggs, this must be admitted as a possibility which may occur rarely. On the other hand it is much more likely that they will be discovered and destroyed. Furthermore, if they do escape from the patient, the chance of their reaching another host on which they might mature is exceedingly small. The patient usually is in the house and in bed under such circumstances, and if the tick leaves the patient it would have to travel much farther than ticks customarily travel in order to reach a second host. The chances are much greater that such a tick would reach another person and cause another case of spotted fever, and this we know must occur rarely on account of the small number of instances in which two cases of spotetd fever occur in the same house during a given season. The very remote possibility exists that such a tick after reaching a second person may be carried outside, where it may eventually mature on another animal.

The existence of spotted fever in a number of distinct foci separated by zones in which the disease does not occur is further evidence that some source of infection for the ticks, other than man, exists in nature.

On the basis of the above considerations, the conclusion was reached that the maintenance of spotted fever probably rests on the combined operation of two conditions, each of which is

essential, namely, "hereditary" transmission of the virus in the tick, and the subsequent infection of susceptble animals, from which hitherto uninfected ticks acquire the disease. In other words the condition appears to be that of an unending alternation of the virus between ticks and anmals, supplemented by "hereditary" transmission in the tick.

Therefore the future study of the "spotted fever problem" resolves itself into a search for animals which may suffer from spotted fever in nature.

SELECTION OF THE ANIMALS TO BE STUDIED.

The method of work planned was first to determine which animals are susceptible to the artificial inoculation of the disease by the injection of diseased blood from the guinea-pig; then to determine whether or not such susceptible animals could be infected by means of the tick. After the result of this work should be in hand, the process of searching for those species which actually suffer from spotted fever in nature, could be begun. In pursuing this last stage of the problem two methods are open: First, to attempt to find animals which are suffering from the disease at the time of their capture; or, second, to attempt to find animals which have had the disease at some past time, with the consequence that they now are immune, the method of determination being that of the immunity test. The problem is very extensive and must necessarily cover a good deal of time, hence it was not anticipated that it could be brought to a conclusion in the work of one season.

The number of animals in the Bitter Root Valley is so large that, manifestly, some discretion should be exercised in the choice of those to be studied. It was very desirable to exclude as many as possible from the study, if correct reasons could be found for doing so, in order that time might be saved and that the chance of ultimate success might be increased.

Domesticated animals were eliminated from the study, at least for the time being, first because inoculations into the horse, cows, sheep and goat, chickens and pigeons, showed that they have such a high resistence to the disease that it would be unreasonable to suppose that they play any part in its maintenance; and, second, because it seemed probable that the disease would be more common than it is if they played an essential role. The horse and cow, it is true, serve as hosts for the tick to a remark-

able degree, but if they are insusceptible to the bite of the infected tick, they can play no part other than that of nourishing a great many ticks, and perhaps, on occasion, transferring infected ticks to the vicinity of man from some more remote point. Five horses have been inoculated with infected blood from the guinea-pig, the doses ranging from 80 c. c. to 120 c. .c, with the result that one animal positively contracted the disease, and another may have done so,, whereas in the other three instances the animals were proved not to have been infected. This is taken as indicating a high resistence on the part of the horse, so high indeed that it is improbable that a sufficient number of infected ticks to produce the disease would ever reach him at any one time. This is especially true when it is remembered that a very small percentage of the ticks, even in the infected districts, have the disease, as published in the first report. Only one inoculation has been made into the cow and this was negative. Two sheep, two goats, two pigeons and two chickens were injected, also with negative results.

The peculiar limitation of the disease not only to the west side of the valley, but to certain districts on the west side, furnished the chief motive for the selection of certain animals. From this condition it seemed probable that the animal or animals which may suffer from the disease must be of a type which do not wander extensively, which show a tendency to a more or less permanent abode, year after year constructing their nests or digging their holes in close proximity to the abode of the previous year. Therefore it seemed justifiable to exclude from the study, at least for the present, birds and other animals which wander widely, as the bear, deer and elk.

On this basis, then, it was decided to study such animals as the gopher or ground squirrel, the wood-chuck or ground-hog, rock squirrel, chipmonk, mountain rat, pine squirrel, the various rabbits, the rock rabbit or "pika," and any other animals which answer the requirements mentioned. In addition it was possible that the number might be still further cut down by determining which species are utilized as hosts by the tick, since none could be concerned in the maintenance of the disease which are not fed on by the particular tick which is known to transmit spotted fever. Observations have shown however that practically all of these animals serve as hosts for the tick, so that the number to be studied could not be reduced on this basis.

It was also important to determine the nature of the infection in those animals which were found to be susceptible, i. e., whether the disease is acute or chronic in them. The importance of this lies in the following consideration: if, in all susceptible animals, the disease is exclusively an acute infection, "hereditary" transmission in the tick is essential to its maintenance, as assumed in the tentative conclusion stated above. On the other hand, if certain of them suffer from the disease in a chronic form, which may cover a period of several months or a year, "hereditary" transmission in the tick would not be absolutely essential to the maintenance of the infection. Each generation of the tick could, in the latter case, acquire the disease afresh each season. This was determined to the point of probability in relation to some of the animals studied, the indications being that it is an acute infection in all susceptible species.

THE GOPHER OR GROUND SQUIRREL.

In the spring and summer of 1907 a series of gophers was inoculated with the blood of infected guinea-pigs with results which apparently were not uniform.

The following is a resume of the experiments:

In all, 18 gophers were inoculated. Four of these, which were injected with the blood of a human patient, concerning the nature of whose infection there was doubt, are taken out of consideration. Of the remaining 14 all were inoculated with the blood or organs of guinea-pigs, except two, which received blood from a patient. One of the latter escaped, however, so that only one satisfactory inoculation from man remained, and a total of 13 animals were left for consideration.

As a means of interpreting infection in the gopher it was supposed that its temperature would be as safe a guide as in the case of the guinea-pig and monkey. It was somewhat surprising therefore that the results in the different animals were very inconstant. Of the thirteen gophers a greater or less degree of fever occurred in nine. The shortest febrile period observed was one day, and it persisted no longer than four consecutive days in any of them; in four animals it lasted for three days and in another for two. In four out of the thirteen absolutely no fever occurred, and at the time it was supposed that they had not been infected.

The incubation period varied from one to five days. It was

five days in one animal, four days in two, three days in four, two days in one, and one day in one animal. During the inoculation period the temperature varied between 100 and 103, being for the most part below 102.5. One observation was as low as 97.8. After the cessation of fever the temperature returned to about what it was during the incubation period.

Of the entire group only one died following the inoculation (No. 1), this occurring after eight days. That the animal had spotted fever in this instance was proved by the injection of blood taken at the time of death into guinea-pig 470. Two days after inoculation the latter developed a course of fever accompanied by hemorrhage into and gangrene of the scrotum.

The infection was proved in only one other instance. This was in connection wth gopher 9. It showed fever on the second and third days after inoculation, and the temperature was 102 on the fourth day. On the fifth day the animal was killed and 5 c. c. of its blood injected into guinea-pig 574 and an emulsion of its spleen into 575. Both guinea-pigs ran typical and fatal courses of spotted fever, as shown by their temperatures, hemorrhages into the scrotum and the changes in the lymph glands and spleen seen at autopsy.

The post mortem changes found in the gopher that died (No. 1) were not numerous. The spleen was about 3 inches long and rather thick, being noticeably larger than that of a control of the same size; it was cyanotic in color. The lymph glands appeared enlarged but were not congested or hemorrhagic. Cutaneous hemorrhages could not be discovered and other organs appeared normal. No characteristic external phenomena of spotted fever were noted in any case.

Immunity tests as performed on the guinea-pig appeared to be of little or no value when applied to the gopher, inasmuch as the temperature of the latter was so inconstant. In two instances, in which the primary inoculations were followed by a greater or less degree of temperature the second inoculations (immunity tests) were followed by none.

In all cases the amount of virus used was greatly in excess of that required to infect the guinea-pig, and inasmuch as four of the animals showed no febrile reaction while the other nine did, and inasmuch as the infection was proved in two of the latter, it is manifest either that the temperature of the gopher is not a reliable index of his infection, or that his susceptibility

is not uniform. All the individuals were captured in districts in whch spotted fever has never occurred, hence it was assumed that none had ever had the opportunity to become infected prior to the experiments, as a result of which they might have acquired immunity. They came chiefly from the base of Mt. Sentinal in Missoula.

The temperatures of a number of normal gophers were taken for several consecutive days in order to learn its natural variations. It was found to be very inconstant and the irregularities were not always to be accounted for. When the weather was cool, as in the mornings it was common to observe a low temperature, and for several days it might remain in the vicinity of 97 or 98. At other times it was low when the outside temperature was too high to account for the condition. That of the normal animal rarely exceeded 102.5 or 103, and it was concluded that this would represent approximately its normal temperature when in a state of normal activity, and with metabolism at par. The fact that the gopher is a hibernating and a semi-cold-blooded animal, no doubt is largely responsible for many of the variations in its temperature. When in actual hibernation the temperature in three instances was so low that it did not register on the ordinary clinical thermometer. It has been observed also that there are individual variations in the tendency to go into the somnolent state, that even at the warm temperature of the laboratory one may be so somnolent that he can be taken out and handled without awakening, while others will be quite active. There probably are various degrees of this metabolic inactivity, and corresponding variations in the temperature probably occur. It seemed more probable, therefore, that the temperature of the gopher is not a good index of his infection, rather than that 30 per cent of the species should be naturally resistent to the disease.

STUDIES WITH THE GOPHER IN 1908.

In view of the considerations presented above, it was decided for the work of 1908 to prove all infections in the gopher by making transfers of blood from this animal to the guinea-pig, the disease being easily recognized in the latter. This was done with but few exceptions, and in these instances the animals are ruled out of consideration.

The following experiments were designed to show whether

or not gophers from uninfected districts are uniformly susceptible, and the degree of their susceptibility as indicated by the minimum infective dose of blood from the diseased guinea-pig. The virus from the guinea-pig was taken uniformly on the third day of fever in order that its virulence might be as constant as possible in different experiments. The blood of the diseased guinea-pig is referred to as "virus" for the sake of brevity. The virus used for most of the experiments represented the so-called "Bradley strain," which was obtained in 1906 and had been cultivated in the guinea-pig for approximately two years. As a consequence of the long residence in this animal it may have undergone either an increase or a decrease in its virulence for any other particular animal, but this point was not determined, and because of the gopher's susceptibility to the bite of the infected tick, as shown later, its determination was not necessary. It would be desirable to know the virulence of the "tick virus" for the gopher as compared with that cultivated in the guinea-pig, but comparative work of this character is not possible since there is no way of controlling the amount of virus injected by the tick.

The gophers were all from Mt. Sentinal, and since no spotted fever has ever occurred in that region, it was assumed that they had never been exposed to the natural infection.

The injections were intraperitoneal.

No. Of Gopher	Amount Injected	RESULT IN GOPHER	Tested on guinea-p. No,	Result in g. p., therefore in Gopher
5	3 c.c.	Killed in bleeding	1319	Infected
6	3 c.c.	Killed in bleeding	1320	Infected
7	2 c.c.	Killed in bleeding	1321	Infected
8	2 c.c.	Died of peritonitis	Not tested	?
9	1 c.c.	Killed in bleeding	1322	Infected
10	1 c.c.	Killed in bleeding	1323	Infected
11	0.5 c.c.	Died before infection could be determined. Cause of death unknown...		
12	0.5 c.c.	Moribund on 5th day	1318	Infected
20	0.3 c.c.	Died in 15 days	1376	Infected
19	0.1 c.c.	Recovered	1377	Infected
18	0.06 c.c.	Died in 12 days	1378	Infected
17	0.02 c.c.	Died in 9 days	1379	Infected

In addition to the series just cited it was necessary, in the course of various experiments, to inject infected blood into twelve other gophers. Their infection was proved by transfers of blood to guinea-pigs on the second to the sixth days after inoculation, with the same results as above.

It is manifest from these experiments that the normal susceptibility of the gopher to spotted fever may be regarded as uniform, at least for all practical purposes. It is likely that individual variations would be encountered in the course of many experiments, as is true of most infectious diseases. Inasmuch, however, as 0.02 c. c. of infected blood is able to cause the disease in this animal, it is safe to conclude that all members of the species can be infected readilv by the use of a dose of reasonable size, say 0.5 c. c. This is, relatively, so large that the final result over a large series of animals could not well be influenced by the range of individual variations which is likely to exist. The guinea-pig is regarded as highly susceptible, since 0.01 c. c. invariably, 0.005 frequently, and 0.001 c. c. occasionally produces infection in him; if 0.02 c. c. infects the gopher, his susceptibility must be close to that of the gunea-pig. The lowest possible dose which is capable of infecting the gopher was not determined.

IS SPOTTED FEVER IN THE GOPHER AN ACUTE OR A CHRONIC INFECTION.

The importance of determining this point, as bearing on the duration of the period during which ticks might become infected from animals, was mentioned above.

The plan followed was to inoculate the gophers with virus, and at various later periods to draw blood from them for the purpose of inoculating guinea-pigs. If the latter should develop spotted fever it is positive proof that the gophers were infected at the time the blood was drawn. If, on the other hand, the guinea-pigs fail to show the disease it is reasonably good proof that the blood of the gophers contained no virus.

In the following summary the 24 gophers already referred to are included.

Date after inoculation of gopher, on which transfers were made to guinea-pig.	Number of experi-ments.	Result in guinea-pig, and the presence or absence of virus in the blood of the gopher.
1 day	1	Guinea-pig not infected, hence no virus in blood of gopher ....
2 days	2	Guinea-pig infected, hence virus in blood of gopher ....
4 days	2	Guinea-pig infected, hence virus in blood of gopher ....
5 days	15	Guinea-pig infected, hence virus in blood of gopher (in all experiments)
6 days	5	Guinea-pig infected, hence virus in blood of gopher (in all experiments)
8 days	1	Guinea-pig infected, hence virus in blood of gopher ....
15 days	5	Virus positively absent from blood in two experiments. In the remaining three, guinea-pigs showed some temperature, which, however, was not typical for spotted fever ....
18 days	1	Virus absent from blood of gopher; guinea-pig not infected ....
46 days	1	Virus absent from blood of gopher; guinea-pig not infected ....

It is justifiable to conclude from these results that spotted fever is acute in the gopher, at least so far as generalized infection is concerned. It must be admitted as possible that the virus may slumber in some one of the internal organs after the acute and general infection is over, and that on occasion it may invade the circulation again, a condition for which we have analogies, as in malaria. This point was not attacked directly, but the results of a study of immunity in the gopher render the existence of such a condition improbable.

IMMUNITY IN THE GOPHER.

If one attack of spotted fever in the gopher renders him immune to further inoculations it is corroborative evidence, though not absolute proof, that he has recovered completely from the infection.

Five gophers were inoculated with virus from the guinea-pig, and their infection was proved by the positive outcome of transfers of their blood to guinea-pigs five days later. Eighteen days after their inoculation they again received injections of virus from the guinea-pig, and five days later transfers of their blood were again made into fresh guinea-pigs.* None of the latter contracted spotted fever as a consequence; therefore the gophers had resisted an infection to which they were primarily susceptible, the same dosage of virus being used. One attack

* The period of five days was chosen because the virus has invariably been present in the blood of the gophers at this time.

of the disease had conferred immunity to further attacks. It will be learned later whether this immunity in the gopher extends over a much longer period, as it does in the guinea-pig and monkey. Analogies teach us that such is probably the case.

There is still further reason for believing that the recovery of the gopher is complete and that he is thereafter immune from the fact that his blood and serum contain protective antibodies in fairly high concentration. For example: Gopher 14 was infected by two ticks (Nos. 1 and 5) on May 22, 1908. Its infection was proved by the inoculation of its blood into guinea-pig 1367 five days after the tick was first attached; the guinea-pig died of spotted fever ten days later. After a lapse of 47 days the gopher was killed in order to obtain its serum. In the test of its protective power, guinea-pig 1503 received 1 c. c. of virus,* plus 0.4 c. c. of the gopher's serum; and guinea-pig 1504, 1 c. c. of virus, plus 1.0 c. c. of the serum. Neither of the guinea-pigs developed fever, whereas a control which received 1 c. c. of virus, plus 2.5 c. c. of serum from a normal gopher developed a typical course of spotted fever. Similar results were obtained with the blood of gopher 9, which was infected on April 22. In the test performed 19 days later its defibrinated blood in quantities of 2.0, 1.0 and 0.5 c. c. protected against 1.0 c. c. of virus, although the smallest dose may not have afforded complete protection. As a control, 3 c. c. of defibrinated blood from the normal gopher afforded no protection, the guinea-pig dying of spotted fever on the 16th day.

The question of passive immunity with the blood of the gopher may well be worked out in greater detail later, but the experiments demonstrate the essential point: that recovery of the gopher is marked by the appearance of protective antibodies in his blood, which in their quantity approximate those which are present in the blood of the immune guinea-pig and horse. This result is to be taken as further proof that spotted fever in the gopher is exclusively an acute infection. It would seem that the presence of such a quantity of protective antibodies in the body fluids of the gopher would be incompatible with his continued infection, although theoretical possibilities to the contrary may exist.

* 1 c.c. of virus, i. e., defibrinated blood from the guinea-pig on its 3rd day of fever, contains at least 100 pathogenic doses for the guinea-pig.

TICK EXPERIMENTS WITH THE GOPHER.

If the gopher suffers from spotted fever under natural conditions, he must acquire his infection through the bite of the tick. Inasmuch as it would not be justified to assume that he is susceptible to the bite of the infected tick because he can be infected by the injection of virus from the guinea-pig, it was necessary to produce the disease in the gopher with ticks which were known to be infected.

Infection of the Gopher With the Tick.

The ticks used in these experiments had been "brought up" on infected guinea-pigs, but before being used their infectivity was first proved on fresh guinea-pigs.

Ticks 1 and 5 were placed on gopher 14 May 22. Tick 1 had infected guinea-pig 1338 on May 15, and No. 5 guinea-pig 1353, on May 17. The two fed on gopher 14 for about 70 hours. Three days after the ticks became attached, the temperature of the gopher rose to 103.4 and ranged between this point and 104.4 for five days, after which it returned to normal. In this instance the gopher showed true fever, its temperature rising two degrees above its supposed normal, 102.5. On the third day of its fever, 0.5 to 1.0 c. c. of its blood was injected into guinea-pig 1367, which, after an incubation period of three days, developed fever and died on the tenth day after inoculation, with clinical and anatomical phenomena which are characteristic for spotted fever.

An exactly similar result was realized with gopher 16, which was infected by tick No. 14. This animal showed no fever at all, but blood drawn from its heart six days after the tick was attached produced spotted fever in guinea-pig 1372. The latter recovered and resisted an immunity test given two weeks later.

Infection of the Tick From the Gopher.

The converse of this condition also was produced, namely, the transfer of the disease to the tick when the latter feeds on the infected gopher.

Thus gopher 22, on June 16, received intraperitoneally 3 c. c. of virus from the guinea-pig. Five days later its infection was proved by the inoculation of some of its blood into guinea-pig 1407, which passed through a typical clinical course of spotted fever, showing genital hemorrhages; the latter recovered. Two days after the inoculation of the gopher, hitherto uninfected ticks

(proved on guinea-pigs 1383 and 1389) were attached to its ears and allowed to feed until the animal died, three days later. The ticks were then removed, and after a lapse of three days were allowed to feed on guinea-pig 1414, which, after an incubation of three days, developed the disease in typical form and died five days later. The conditions at autopsy were typical for spotted fever.

"Tick Cycle" Experiments.

In addition to these experiments it was thought desirable to imitate as far as possible the conditions which must prevail in nature, namely, to first infect the gopher with the tick, and then to allow normal ticks to acquire the disease from the same animal. This was done in two instances, which, for the sake of convenience, are called "tick cycle" experiments.

Experiment 1. The infectivity of tick 2 was proved on guinea-pig 1346 May 12. Eleven days later it was allowed to become attached to gopher 15 on which it fed for about 141 hours. The gopher had one day of true fever (104.1), in which the temperature rose above the normal for this animal. Six days after the tick became attached blood was drawn from the heart of the animal and 3 c. c. injected into guinea-pig 1370, which died from spotted fever after 15 days. This was done to prove that the gopher had been infected by tick 2. As soon as tick 2 was removed, three normal females from Mt. Sentinal were allowed to become attached to the gopher. The latter died while the tick was feeding, the total time of attachment being 72 hours; 24 hours before death and 48 hours after the death of the gopher. Two of the ticks died leaving one for the test on the guinea-pig. Seven days later this tick was attached to guinea-pig 1384, on which it fed for 21 days. Following this very long incubation period, during which its temperature remained practically normal, the guinea-pig exhibted the following temperature as taken on successve days: 106, 106.4, 104, 105.2, 103, death occurring on the sixth day after fever began. The findings at autopsy were as follows: Vulva much swollen, cyanotic, beginning hemorrhages; lymph glands greatly enlarged, cyanotic, hemorrhagic; spleen much enlarged, cyanotic and somewhat mottled; suprerenal glands enlarged and contain many minute hemorrhages; pleurae show several hemorrhages; bone marrow soft, congested and bluish-red; no changes in the liver, heart,

kidneys or lungs. Cultures from the blood, liver and spleen were sterile. These conditions are typical for spotted fever in the guinea-pig.

Experiment 2. The infectivity of tick 8 was proved on guinea-pig 1356. After an interval of two months and eight days it was attached to gopher 31, on which it fed for 40 to 48 hours. After an incubation period of four days, as indicated by the temperature, three days of fever followed, and at the end of this time the animal died as a consequence of bleeding from the heart. On the seventh day 2.5 c. c. of its heart blood were injected intraperitoneally into guinea-pig 1505, which died 12 days later after a clinical course characteristic of spotted fever, including a swollen and hemorrhagic scrotum, and with autopsy findings which are peculiar to the disease. The infection of the gopher by the tick was thus proved.

In order to obtain the disease in normal ticks, two, which had previously been proved to be uninfected, were attached to the gopher after the infected tick had fed for two days; the latter was removed at the end of that time. Of the "normal" ticks one died, whereas the other fed for four days or until the gopher died. It was immediately placed on a fresh guinea-pig (1514), on which it fed for 10 days without producing infection. Fifteen days later it was tested on a second fresh guinea-pig (1559) with the following course of fever as a consequence: 102, 103, 102, 105. 104.6, 105, 105, ——, 105.6, 103.5, 100.2, death occurring on the 12th day after the tick was first attached. The autopsy was typical for spotted fever. As further corroboration of the success of the experiment, blood from this guinea-pig was injected into guinea-pig 1520 with the same result.

In experiment 2, as in experiment 1, the long incubation period in the tick is noteworthy; it is usually very much shorter.

The success of these "tick cycle" experiments is undoubted, yet it must be explained that the theoretical conditions in nature may not be represented for all cases in the experiments as they were performed. Thus in the maintenance of spotted fever from one season to the next it is probable that the animals become infected through the bites of the larvae or nymphs of infected females, whereas the experiments described were conducted entirely with adult ticks. This is an unessential difference, however, in view of previous work, which shows the readiness with which larvae and nymphs infect the guinea-pig. A single nymph

will infect the guinea-pig, a result which was obtained in two instances in 1906 (Nymphs 1 and 2). The number of larvae required to produce infection is unknown, but if we assume that it is ten or twenty, the conditions in nature render infection by larvae quite intelligible. As larvae emerge from the eggs they "bunch" themselves in masses of hundreds of thousands, and when an animal comes in contact with the mass, a hundred larvae may as well become attached as a smaller number. Fifty larvae were found attached to the ear of a single pine squirrel last summer.

EXPERIMENTS WITH OTHER ANIMALS.

The experiments with the gopher show how it is possible for this animal, acting in conjunction with the tick, to be responsible for the maintenance of spotted fever from one year to the next. Inasmuch, however, as there are other animals which have habits similar to those of the gopher, and which are also used as hosts by the tick, it is manifest that they should be subjected to similar studies. During the time available, such studies were carried as far as possible with three other species (rock squirrel, chipmonk, wood-chuck), and work was begun on a fourth (mountain rat).

The Rock Squirrel.

The animal bearing this local name lives in both infected and uninfected districts. It is somewhat smaller than the ground squirrel or gopher, has a dark gray back, a tail of the same color about four inches long a lighter gray ventral surface, and two black stripes separated by a light gray stripe on each side. The head is reddish in color. It has the teeth of a rodent. It burrows and hibernates and seemingly prefers to have its home in the ground beneath masses of loose rock, although this is not always the case. In the Lo Lo Valley many of their holes are seen in the wall of a cut made by the road.

Ticks feed on them extensively, at least during the larval and nymphal stages. On June 11, 40 nymphs were found on one animal in various stages of enlargement, and on August 12 many were found on several animals killed in the Lo Lo Valley. Some of these ticks were later induced to mature on guinea-pigs, and after molting proved to be specimens of the tick which is concerned in the transmission of spotted fever.

Susceptibility to Inoculation.

On June 26, rock squirrel No. 1 received intraperitoneally 1 c. c. of virus from guinea-pig 1390. It died four days later showing a temperature of 104 on the third day. The lymph glands were enlarged and congested, and the spleen greatly enlarged as compared with that from a normal animal of the same size. No other anatomic changes were noted. An inoculation on agar from the heart's blood was sterile.

After the death of the squirrel a tissue emulsion and some of its heart's blood were injected into guinea-pig 1411, which after an incubation period of three days exhibited a course of high fever lasting for 13 days. The animal recovered, but resisted a second inoculation, indicating its infection with the blood of the squirrel in the first instance.

Rock squirrel No. 2 died five days after inoculation with 1 c. c. of infected blood from the guinea-pig. It showed a temperature of 104.6 and 103 on the third and fourth days after inoculation. Its spleen was greatly enlarged and lymph glands were congested. Infection was not proved by transfer into the guinea-pig.

Rock squirrel 3, inoculated with 1 c. c. of virus from the guinea-pig, died four days later without showing fever. Same autopsy findings as in preceding animals, complicated by pericardial hemorrhage which followed bleeding from the heart. Blood taken on the third day and injected into guinea-pig 1522 caused characteristic and fatal spotted fever.

TICK EXPERIMENTS WITH THE ROCK SQUIRREL.

Experiment 1. Infection of Tick From Diseased Rock Squirrel.

Rock squirrel 1, mentioned above, was inoculated on June 21. Two days later normal ticks from Mt. Sentinel were allowed to become attached to the animal. They fed for 30 to 40 hours. Two days later, these ticks, three males and one female, were attached to guinea-pig 1425, on which they fed more or less constantly for eight or ten days. They were then removed. The animal developed no symptoms of spotted fever.

On July 14, 19 days after their removal from the rock squirrel, two of the females were attached to a fresh guinea-pig (1459) and later the other two were attached. They all fed irregularly, and had to be reattached frequently, so that the extent of their feeding was not determined. On the seventh day

after the first tick became attached, however, the temperature of the guinea-pig rose to 104.4, and for eight days ranged between 103.6 and 106.2, recovery eventually taking place. The scrotum became hemorrhagic and the animal later resisted an immunity test, which proves its infection by the ticks.

Experiment 2. "Tick Cycle" Experiment.

The infectivity of tick 18, female, was proved on guinea-pig 1458 on July 13. Fifteen days later it was attached to the ear of rock squirrel 3, on which it fed for 72 hours. The incubation period in the rock squirrel was uncertain but may have been two days or less, as indicated by its temperature. The course of temperature was as follows: 102, 104.7, 102.2 A. M., 106 P. M., 103, ——, 104, 102, 104.3, 102.1, 101.4, 103.2, 101.6, 100.6, 101.4, 104, subnormal, death; a course so irregular that it affords little or no basis for interpreting infection. The infection of the rock squirrel was proved by the inoculation of some of its blood, drawn on the fifth day after the attachment of the tick into guinea-pig 1506. The course of temperature shown by 1506 on successive days was as follows: 102, 103.6, 104.7, 104.6, 106, 105.3, 106, 106, 104.3, 103, 103, 101.6, 101.4. The vulva became hemorrhagic on the tenth day. The animal recovered and was given an immunity test, to which it showed no reaction; there is thus double proof of its infection by the rock squirrel. The infection of the latter was again proved by blood drawn and inoculated into guinea-pig 1511, on the seventh day after the attachment of the tick. This guinea-pig died of typical spotted fever nine days after its inoculation. Blood taken from the rock squirrel on the 12th and 16th days after the attachment of the tick did not prove infective for guinea-pigs.

The organs of the rock squirrel after death showed little that is characteristic for spotted fever. The spleen was somewhat enlarged as compared with that of a normal rock squirrel.

Inasmuch as blood drawn on the 12th and 16th days did not cause spotted fever in the guinea-pig, the question may arise as to whether this disease was the sole cause of the death of the rock squirrel. In answer to this it may be stated that the virus often appears to be absent from the circulating blood late in the disease even when the animal dies; this is in relation to guinea-pigs, and the condition may be met in the rock squirrel and other animals. It is not yet certain that the virus absolutely

disappears from the blood at this time, but it may be mixed with such a quantity of immune bodies that the latter prevent infection when the blood is transferred to another animal.

When the infected tick was removed from the squirrel, i. e., after being attached for three days, two normal ticks were allowed to become attached. These ticks had been previously tested on guinea-pigs and had been found uninfected. One of the two "normal" ticks was killed during the feeding; the other fed for 104 hours, from the third to the eighth days after the attachment of the infected tick. Immediately after its removal from the rock squirrel the remaining "normal" tick was attached to the ear of the guinea-pig 1515 on which it fed for seven or eight days. On the sixth day the temperature of the guinea-pig rose to 103.4, and on successive days it was recorded as follows: 103.2, 104, 104.6, 105, 104.6. 102.4, 100.4, death. The incubation period was seven or eight days. The changes in the organs were those seen in spotted fever, but they were not pronounced. However, the infection of this animal was proved satisfactorily by the inoculation of 2 c. c. of its blood, drawn on the third day of high fever, into guinea-pig 1553, which passed through a typical course of fever, showing a swollen scrotum which became hemorrhagic on the 12th day.

The "tick cycle" experiment, therefore, was positive.

Duration in the Rock Squirrel.

Experiments to determine the duration of spotted fever in the rock squirrel were not carried to completion, but some data were obtained which indicate that it is an acute rather than a chronic disease in this animal.

Virus drawn on the third, fourth and seventh days after their inoculation with infected blood proved infective for guinea-pigs (rock squirrels 1, 4 and 5). In the case of infection by ticks, blood drawn on the fifth and seventh days after the attachment of infected ticks proved infective for guinea-pigs (rock squirrel 3). On the 12th and 16th days after the attachment of the infected tick, the blood of rock squirrel 3 was not infective, as above stated. The blood of rock squirrel 5 was infective on the seventh day after its inoculation, but not on the second, fourth, fifth and tenth days. These results may not hold when the internal organs are used for inoculation, as previously stated in relation to the gopher.

Immunity tests with the rock squirrel have not yet been performed.

The experiments cited show that the rock squirrel, as well as the gopher, is adapted to the maintenance of spotted fever in nature, acting in conjunction with the tick.

THE WOOD-CHUCK.

The wood-chuck has been found to be susceptible to spotted fever both by the inoculation of infected blood and by the bite of the infected wood-tick, although the experiments are few in number.

Infection by Inoculation.

On May 31 wood-chuck 1 received 5 c. c. of virus from guinea-pig 1350. The temperature for six days was as follows: 101.4, 101.2, 99 8, 102.2, 102, 103.4. At this time the animal died as a consequence of being bled from the heart. No striking anatomical changes were found at autopsy. On the sixth day 3 c. c. of blood from the animal were injected into guinea-pig 1364, the latter showing the following course of temperature on successive days: 102.6, 104, 102.4, 106.6, 106.5, 106, 105.2, 105.8, 105.5, 104.9, 104.6, 104.4, death. At autopsy the scrotum was swollen and hemorrhagic; lymph glands enlarged and intensely congested or hemorrhagic and surrounding areolar tissue deeply congested; spleen greatly enlarged, cyanotic and of about normal consistence; kidneys pale and enlarged; hemorrhagic points in suprarenal glands; no changes in heart, lungs or liver.

Wood-chuck 2, a young animal, received 5 c. c. of virus intraperitoneally on May 26. Three days later it was moribund, having shown no fever. At this time 0.5 to 1.0 c. c. of its blood was injected intraperitoneally into guinea-pig 1371, which suffered from a typical and fatal course of spotted fever, thus proving the infection of the wood-chuck. Course of temperature on successive days: 102.5, 102.7, 102.2, 102.4, 105, 105.4, 105, 104.9, 105.9, 104.7, 104.2, 103.2, 102.5, 102, 101.6, 102.8, 103.2, 103, death Autopsy: typical for spotted fever; scrotum swollen and hemorrhagic; lymph glands much enlarged, congested and hemorrhagic; spleen enlarged and cyanotic; no changes in other organs.

Complete data as to the duration of the disease in the wood-chuck, as bearing on its chronicity, was not obtained, owing to the accidental death of some of the animals when they were bled from the heart. The blood was found infective on the

second day after inoculation in one instance (wood-chuck 5), and on the third and eighth days in two others (Nos. 1 and 2).

"Tick Cycle" Experiment With the Wood-Chuck.

Four ticks were used in the infection of wood-chuck 3. Tick 1 infected guinea-pig 1338 on May 10; tick 4, guinea-pig 1349, on May 16; tick 2, guinea-pig 1346, on May 13; tick 12, guinea-pig 1387, on June 9.

On June 18 tick 1 was attached to wood-chuck 3 on which it fed for 50 to 60 hours, when it was scratched off and killed. June 21 tick 4 fed for a few hours when it was also killed. June 22 tick 2 was attached and fed for an unknown period, but not more than a few hours. June 24 tick 12 was attached during the afternoon, but became detached during the night. The temperature exhibited by the wood-chuck from the time of attachment of the first tick until 18 days later was as follows on consecutive days: 99.6, 98.6, 99, 97.2, 101, 104, (P. M. 103.3), 103.4 (P. M. 104), 101.4, 100, 102.4, ——, 102.5, 103.1, 102.3, 102.4, ——, 100.6, 101.6. On the second or third day after the temperature rose the animal appeared sick and for a few days its recovery seemed doubtful. It recovered but died later of uncertain causes. On the first day of distinct fever (104.3) blood was drawn from the heart, of which 1 c. c. was injected into guinea-pig 1409, and 3 c. c. into 1410. Temperature of guinea-pig 1409 on successive days: 102.4, 102.8, 102.4, 102.6, 106, 106.7, 106.9, 106.1, 105.4, 106.6, 104.6, 105, 104, 104, 102.4, 100.6, subnormal, death. The scrotum became hemorrhagic on the ninth day. Temperature of 1410: 102.4, 103.2, 102.6, 102.2, 105.3, 106.1, 105.7, 105, 102.5, death. Scrotum hemorrhagic on the eighth day. The autopsies of both animals were typical for spotted fever as regards cutaneous hemorrhages, enlarged and hemorrhagic lymph glands, enlarged and cyanotic spleen and sterility of culture tubes inoculated with heart's blood. Hence the infection of the wood-chuck by the ticks was proved.

On the first day of high fever five normal ticks were attached to the wood-chuck in order that they might become infected. Four of them fed for 39 hours, at which point they were removed (June 26), the fifth having been killed.

June 30 the "normal" ticks were attached to the ear of 1432, on which they fed almost constantly for nine days. They were then removed. Two or three days later fever appeared in the guinea-pig (103.3-104.8) and continued for about two weeks.

Spotted fever was suspected at the time, but two corroborative diagnostic tests showed that this was not the case. First, some of 1432's blood drawn on the fourth day of fever failed to cause spotted fever in a fresh guinea-pig (1464); and, second, 1432, after the fever has subsided, developed fatal spotted fever when an immunity test was given.

A second test of these guinea-pigs was made July 23 (guinea-pig 1484). All fed slightly but irregularly until the 26th, after which two of them remained attached for two days. Temperature of 1484 on successive days: 103.6, 102.4, 103.1, 103, 102.6, 102.9, 102, 105.1, 105.1, 106.4, 106.1, 104.6, 104, 103.6, 101.6, 101.8, 102.4. Death occurred subsequently from pseudo tuberculosis. During the course of the fever the scrotum became much swollen, and the ears eventually sloughed off, which occurs rather frequently in spotted fever in the guinea-pig. On the fourth day of fever 1 c. c. of its heart's blood was injected into guinea-pig 1507, for the purpose of corroboration. This animal died of spotted fever 14 days after the inoculation, thus furnishing corroborative evidence of the infection of 1484.

The wood-chuck, then, is a third animal which, when acting in conjunction with the tick is able to play a part in the maintenance of spotted fever. The extent to which ticks feed on the wood-chuck was not determined last season. However, nymphs were found on them on two occasions during July.

THE CHIPMONK.

The chipmonks used for these experiments came from regions in which spotted fever has not prevailed, hence it was assumed that they had never been exposed to the disease.

On account of the small size of the chipmonk, and the comparatively large size of the clinical thermometers used, the temperature of these animals was not taken regularly. When it was taken it seemed not to be typical or constant, therefore unreliable.

June 21 chipmonk 1 received intraperitoneally 1 c. c. of infected blood from the guinea-pig (Bradley strain). Three days later it was moribund, and 1 c. c. of its heart's blood was injected into guinea-pig 1408. The temperature of 1408 on successive days was as follows: 103.2, 102.6, 102.2, 103.6, 106.1, 106.8, 106.2, 106.6, 105.6, 105.6, 104.5, 104.2, 104.4, 103.2, 102.8, recovery. The animal resisted an immunity test given 15 days later,

proving its infection from the chipmonk, and hence of the chipmonk itself.

June 17 chipmonk 2 was inoculated in the same way. It died three days later, this result perhaps being hastened by the confinement of the animal in a cloth pillary for the attachment of ticks. From 0.2 to 0.3 c. c. of its heart's blood was injected into guinea-pig 1431, which died of spotted fever 11 days later, the autopsy being typical. Cultures from chipmonk 2, as from No. 1, remained sterile. as is customary in uncomplicated spotted fever.

Chipmonks 7 and 9 were inoculated each with 0.5 c. c. of virus from the guinea-pig (August 5). On the fourth and eighth days after the inoculation of No. 7, blood drawn from its heart infected guinea-pigs 1540 and 1548 respectively, the former dying, whereas the latter recovered. The autopsy of 1540 was typical for spotted fever. Also blood drawn from No. 9 on the second day after its inoculation produced severe but not fatal fever in guinea-pig 1535.

The duration of spotted fever in the chipmonk, as bearing on the possiblity of chronicity, was not determined. The experiments cited show that the virus is present in the blood on the second, third, fourth, sixth (No. 10) and eighth days after the injection of infected blood.

The number of animals dealt with was too few to show the true virulence of the disease for the chipmonk. Some of the animals were confined rather closely, but at the same time comfortably, in pillories made of cloth, in the routine of tick experiments. A certain amount of exhaustion under these circumstances may have increased the mortality.

EXPERIMENTS WITH THE TICK.

Chipmonks 3, 5, 10 and 11 were infected by the bites of ticks.

Chipmonk No. 3. The infectivity of tick 13 (female) was proved on guinea-pig 1433, June 30, the animal recovering and resisting a later immunity test (July 15). On July 10 tick 13 became attached to chipmonk 3, feeding for from two to three days. The animal was confined in a cloth pillory to prevent the tick from being scratched off, and died on the fifth day. From 0.2 to 0.3 c. c. of its heart's blood, taken after death, produced fatal spotted fever in guinea-pig 1462, which showed the following course of temperature on successive days: 103.4, 103.9, 105.6,

106.2, 105.4, 105.4, 105.2, 105.3, 104, subnormal, death. The scrotum became hemorrhagic on the sixth day, and gangrenous on the tenth day. The autopsy was typical for spotted fever; scrotum swollen and hemorrhagic; tunica vaginalis and epididymus intensely congested; lymph glands greatly enlarged, congested or hemorrhagic, and cyanotic; spleen much enlarged and cyanotic; suprarenals enlarged and congested. No changes in other organs. No anatomical changes characteristic for spotted fever were detected in the chipmonk.

Chipmonk 5. The infectivity of tick 17 (female) was proved on guinea-pig 1457, July 18, the animal dying of the disease. August 1 it became attached to chipmonk 5, on which it fed for two days and sixteen hours. The animal died on the third day, with no characteristic changes in his organs. At the time of its death from 0.2 to 0.3 c. c. of its blood was injected into guinea-pig 1512, which died of spotted fever after nine days. The temperature was as follows: 102.3, 103, 103, 106, 104, 104.5, 102.3, death. Autopsy: Spleen enormously enlarged, cyanotic and rather friable; lymph glands enlarged and deeply congested; axillary lymph glands hemorrhagic; epididymus and tunica vaginalis congested; scrotum not hemorrhagic (early death); kidneys swollen and pale; suparenals congested but little enlarged; bone marrow very red; no other changes seen. Cultures from heart's blood remained sterile.

Chipmonk 10. The same tick (17) was used in infecting chipmonk 10, on August 6. It was attached for 145 hours. The animal died six days after the attachment of the tick, without showing any distinct changes in the organs at autopsy. The spleen appeared somewhat enlarged when compared with that of a normal animal. At the time of death about 0.5 c. c. of its blood was injected into guinea-pig 1314, which passed through a typical course of spotted fever, as indicated by the temperature, hemorrhage into and sloughing of the scrotum; it recovered.

"Tick Cycle" Experiments.

Experiments of this type were instituted several times. The first step in some of them has already been described above under the heading of "Experiments with the tick." The second step, namely, the infection of normal ticks from the chipmonk, after the latter had been infected by a "proved" tick, failed in some instances because the animals died too soon. In two other

experiments (chipmonks 3 and 10), the experiments were carried through completely, but the "normal" ticks failed to infect the guinea-pigs, hence the cycles were not completed. In the case of chipmonk 5 the cycle possibly was completed, as the "normal" ticks after feeding on the chipmonk produced a course of low fever in guinea-pig 1542. The animal died later of extraneous causes before an immunity test could be given, so the case was not proved.

With persistence, there is little doubt that a successful "tick cycle" experiment can be obtained with the chipmonk. It is infected very readily by the tick, and the virus is present in its blood in considerable concentration, and there seems no reason why normal ticks should not contract the disease from the infected animal.

The Chipmonk as a Host for Ticks.

The chipmonk is used quite extensively as a host for the tick, at least in their larval and nymphal stages. On August 12 as many as 20 or 30 larvae were found on single animals, attached principally to the ears. A number of small nymphs were found on them. It is questionable whether adult ticks could feed to a great extent on the chipmonk. The adults are comparatively large and the animal is so nimble that they could be scratched from almost any part of the body surface.

The results of the experiments cited show that the chipmonk, as well as the animals described above, is capable of playing a part in the maintenance of spotted fever.

THE MOUNTAIN RAT.

Only a beginning was made with the study of the susceptibility of the mountain rat.

Mountain rat 1 received intraperitoneally 2 c. c. of infected blood from the guinea-pig, in this instance the strain being obtained but a few weeks previously from a human case. The temperature taken on successive days was as follows: 102.2, 101.8, 101, 99.4, 102.6, 101.6, 98, 98.5, 100.6, 100.2, 101, 102, 100.7, 101.2, 99, 100, 100.2 Transfers of the animal's blood were made into guinea-pigs on the fourth, eighth, eleventh and twenty-third days after its inoculation. Of the two animals which were inoculated on the fourth day (1498 and 1499), the former, which received 1 c. c. of the rat's blood, died of spotted fever 12 days later. Its temperature was as follows on successive days: 102.

104, 102.4, 103.6, 105.4, 106, 106, 105.5, 105, 104, 103.2, subnormal, death. Autopsy: Typical for spotted fever; scrotum densely hemorrhagic; testicles and tunica vaginalis deeply congested or hemorrhagic; lymph glands swollen and deeply congested or hemorrhagic and cyanotic; spleen only moderately enlarged, as is frequent when death occurs rather late in the disease, and is cyanotic; suprarenals enlarged but not congested; kidneys swollen and moderately pale. No changes noted in other organs. The second animal, which received but 0.5 c. c. of the rat's blood, did not become infected, nor did the other animals inoculated on the eighth, eleventh and twenty-third days. The rat died 16 days after its inoculation, with no anatomical changes which could be detected other than a spleen which may have been somewhat enlarged.

The only data obtained concerning the relationship of the tick to the mountain rat lay in the discovery of a number of nymphs on some of the specimens which were brought in.

OTHER ANIMALS TO BE STUDIED.

A number of other species remain to be studied, inasmuch as the conditions, a priori, would open them to as much suspicion as possible hosts for the virus of spotted fever as those which have been studied. The pine squirrel, the so-called rock rabbit, cotton-tail, snow-shoe and jack rabbits are those the study of which would seem to be of the most importance. During the whole season attempts were made to get these animals by offering liberal prices, but only a few pine squirrels and one snow-shoe rabbit were brought in. The pine squirrels were all injured in one way or another so that they died soon after being received, and the rabbit died before it could be subjected to experiments.

The pine squirrel is utilized very extensively as a host by the spotted fever tick, at least during its larval and nymphal stages. On June 15 a few nymphs were found on them, and on August 12 large numbers of larvae and a few nymphs were found on an animal killed in the Lo Lo Valley.

A NEW SPECIES OF TICK.

A new tick was found on the snow-shoe rabbit during the last season. They were collected from the rabbit west of Victor and sent to me. All that were sent appeared to be females which were well on their way to maturity. They could not be

induced to feed further on the guinea-pig. Some of them laid eggs later, however, and after hatching they were carried into the nymphal stage on rabbits, but could not be carried into the adult stage. Therefore their identification could not be made. It was learned positively, however, through measurements of the egg, larvae and nymphs, the shape of the egg, which is almost spherical, and the shape of the larvae, which is more or less disc-like, that this is a different species from the one which we have determined to be a carrier of spotted fever. The ability or inability of this tick to carry the disease will need investigation in the future.

THE HOSTS OF THE TICK.

Many observations are yet to be made regarding the hosts of the tick, although those which were made during the past year form a decided step in advance and give us a better understanding of its life history.

Up to the present time the adult ticks have been found to feed mainly on the larger animals, such as the horse, cow and certain of the wild animals, as the deer, elk and mountain goat, information concerning the last three coming to me indirectly. I have no doubt also that the adult feeds to a greater or less extent on the rabbit. The spotted fever tick of Idaho was found on snow-shoe rabbits in large quantities, in all stages of their development and at one time.

Impregnation of the female by the male also occurs on the horse and cow, and probably does on the other large hosts also. The impregnated female matures on these animals in large numbers and dropping from them, proceeds to lay the eggs from which the next year's crop is derived. It has been reported to me that very small ticks are also found on the horses at certain times of the year, and this is probably true. So far, however, I have not made this observation.

The condition in relation to the small animals which were studied during the past year is somewhat in contrast to that seen in the larger animals. It would not be correct to say that adult ticks do not feed on the gopher, wood-chuck, pine squirrel and the other small animals mentioned. I have indeed found them occasionally on the gopher. But in spite of this it seems quite certain that they do not feed on them so extensively as on the larger animals. No adults were found on any of the small ani-

mals examined during the past year, at a time when they were still numerous on the horses and cattle.

On the other hand it was learned positively that the gopher, rock squirrel and pine squirrel are utilized as hosts by the larvae and nymphs to an extensive degree, and the same is true, but perhaps to a smaller extent, of the chipmonk, wood-chuck and mountain rat. Minute ticks have also been reported to me as occurring on the "rock rabbit."

The observations are yet too few to allow of positive conclusions in regard to the point, but it seems to be the tendency of the tick to feed on these small animals during the larval and nymphal stages, as well as on the larger animals, but that they either prefer the larger animals during the adult stage, or that the conditions are such that they come in contact with the large animals more readily during this stage. A condition which cannot be without influence on this point, is that of the hibernation of some of the small animals during the period when the adult ticks are most in evidence. The adult ticks are most numerous and most active during the latter part of March, April and May. The hibernating animals are still quiescent in March, and at least for a part of April. During April the outside temperature is still so low, as a rule, that they stay in the open very little, and during May there is so much rainfall that they venture out to a comparatively small extent. I now refer particularly to the conditions in the Bitter Root Valley. With these habits they must come in contact with comparatively few adult ticks.

Another factor mentioned previously renders these small animals unfavorable hosts for adult ticks. The ticks are so large comparatively and the small animals so nimble that a tick of much size is likely to be dislodged by scratching with their sharp claws. A certain number of adults could find a comparatively safe lodgement over the upper dorsal vertebrae and just back of the shoulders. It was in such places that enlarged nymphs were found most frequently on the gopher and rock squirrel, whereas the larvae and nymphs of small size were frequently found on the ears. Even if adults do feed on these animals to some extent, it is very doubtful if females can become mature on them as a routine occurrence, at least while the animals are not in a condition of hibernation. The maturing female offers a very large mark for their sharp claws.

A condition encountered during the past year suggested that

ticks may be carried into the holes of some of these burrowing animals and feed and mature on the latter while they are in a state of hibernation. This concerns the finding of comparatively large numbers of nymphs in various stages of enlargement on gophers and rock squirrels in the latter part of June, a time when practically all the adult ticks had disappeared from the larger animals (horses and cows), and when nymphs were not encountered at large or on the domesticated animals. The presence of the nymphs on such animals at that season is difficult to explain, unless it is assumed that the ticks became attached while the animals were in their holes. The positive conclusion may be drawn that some of the nymphs which were attached to the gophers and rock squirrels at that time surely dropped from these animals when the latter were in their nests. Many of the nymphs were fully enlarged and left the animals a very short time after the latter were captured, and it would be unavoidable that some of them would be distributed in the holes. When this occurs there is nothing to prevent molting of the nymphs and their appearance as adult ticks in due time. During the winter, when the animals are in a quiescent state, such ticks may feed on them at will, and the females may mature, drop off and deposit their eggs in or near the nest. When the eggs hatch, the larvae may feed on the animals which are perhaps still in a quiescent condition. With their later evolution as nymphs, and the attachment of the latter to the animals, the condition encountered last June would again be reproduced.

The positive determination of this point can be made only by some of the animals out at different seasons, making careful examinations of them and their nests.

The importance of making these observations, particularly in relation to the gopher and rock squirrel, cannot be overestimated, as they have an important bearing on the degree of success which will attend attempts at the eradication of the tick.

ERADICATION OF THE TICK.

The principles involved in the eradication of the tick were treated of in Report No. 1., and the details need not be repeated in this place. I wish to modify one statement made in the first report. This concerns the value of clearing off, or burning off, the timber and brush from the infected districts. I have been impressed with the comparative scarcity of ticks in open coun-

try, and believe this is accounted for by the following conditions: First, in the open country ticks are exposed to the destructive action (which may be only a dessicating action) of the sun's rays, whereas in the wooded and brushy country they are protected from this agency to a greater or less degree. Second, the air near the ground is dryer in an open country than in the presence of timber and brush and a dry atmosphere shortens the life of the tick and prevents the hatching of eggs. Third, a timbered country affords shelter and a home for some of the small wild animals which are utilized as hosts by the tick, at least in its larval and nymphal stages.

On the basis of these considerations it is advisable to include in the general campaign against spotted fever the systematic clearing of land now covered with brush and small timber, in those districts which are known to be infected with spotted fever. It would seem that this need not be carried so far as to deprive such territory of all its trees, but that a degree of discretion might be used which would accomplish the purpose without actual devastation. There is more or less land of this character which contains timber of such value as to pay the cost of clearing and perhaps more, and the land would thereby be rendered of still more value for agricultural purposes. In the case of land not taken up the cost of clearing might devolve on the county or state or perhaps in some cases on the federal government.

There is more or less bench land which still holds timber of some value and which might be particularly valuable for the cultivation of fruit when it is cleared and supplied with water. There will thus be compensations for the expense and labor of clearing.

Land farther back in the hills could not reasonably be subjected to such treatment, and there is every reason to believe it would be ineffective if it were carried out in such places.

As emphasized in the first report, the most important procedure for the eradication of the ticks consists in some plan for preventing the females from reaching maturity on the cattle and horses. They feed on these animals so extensively that an enormous reduction in their number will be accomplished when it is prevented. As proof of this the success of the campaign against Texas fever in the south by similar methods may again be called to mind.

The method of oiling these animals with a crude oil during

the period when the adult tick feeds on them (from the middle of March to about the middle of June), repeating the oiling every three or four weeks, as may be learned by experience, is the procedure best suited to the conditions in the Bitter Root Valley. Ticks will not mature on nor become attached to such animals. When they are turned out to graze in the hills, coated with oil, the danger that they may carry infected ticks back to the premises of the owner will be obviated. The dog should be included among the animals to be oiled.

The question naturally arises as to whether this will accomplish the desired result since it has been learned that the tick also feeds on the small animals which have been enumerated. Regarding this point it may be said that the tick probably feeds on these small animals chiefly in the larval and nymphal stages and, if they mature at all on them, it probably is only in minor degree. If it could be shown that the female does not mature on them, except in rare instances, such animals could be neglected entirely, since all that is required is to prevent the maturing of the female. The observations of the past season indicate that the females may mature on some of the hibernating animals to a certain degree, and if further investigations show this to be true, the method of oiling the stock would be ineffective only to the extent to which this occurs. It still remains true that the large host of ticks which mature in proximity to man are those which feed on the cattle and horses, and from these come a large share of the larvae and nymphs which feed on the neighboring small animals.

Again, it should be emphasized that complete extermination of the ticks cannot be expected, and there are reasons for believing that it would not be necessary to carry it so far in order to control spotted fever. In the control of yellow fever it has been found that it is not necessary to exterminate the mosquito completely in the region involved, but that if their number is kept down to a certain minimum, which might be designated as the "safety point," the disease may be controlled. Without question the same would also apply to the control of spotted fever. The infected ticks are not numerous, even in districts which are called badly infected, and their numbers would be decreased in proportion as the whole mass of ticks is increased. With a sufficient reduction in their number, a point will be

reached when, on the basis of chance, an infected tick would be a great rarity. In the meantime investigations now under way may disclose other procedures which will still further limit their number.

There are economic reasons for advocating the extermination of the gopher and rock squirrel, aside from the part they play as hosts for the tick, and as possible hosts for spotted fever. They are very destructive to the crops of small grains.

CONCLUSIONS.

1. Spotted fever is induced by the bite of the tick which has hitherto been referred to as Dermacentor occidentalis* and the disease is "hereditary" in from 7 to 50 per cent of the infected females. Under natural conditions "inheritance" probably takes place in more than 7 per cent and less than 50 per cent.

2. The virus of spotted fever is not an inherent quality of the tick.

3. The tick obtains its virus from some external source which probably coincides with its regular, or more likely its occasional food supply.

4. The tick does not obtain its virus from man.

5. Maintenance of spotted fever from year to year over a long period probably cannot be accomplished solely by "inheritance" of the disease in the tick. The continued fresh infection of ticks would seem to be necessary for this.

6. The tick probably obtains its virus from some one or more of the small wild animals which have habits of segregation, or a tendency to a permanent abode.

8. The number of cases of spotted fever can be reduced by reducing the number of ticks in infected districts, and if a certain low "safety point' 'is reached by the use of thorough methods, spotted fever can be prevented.

9. The most effective single method consists of the oiling of the horses, cattle and other domestic animals on which this tick feeds extensively, as the dog, from about March 15 to about June 15. Another aid consists of the clearing of land which affords protection to the ticks and some of the small hosts on which they feed. The destruction of the small wild animals enumerated may be of value, as destroying hosts for the tick, and possibly hosts for the virus of spotted fever. This may be

determined more positively by future investigations. These methods need be applied only to districts which are known to be infected.

The gopher, rock squirrel, wood-chuck, chipmonk and mountain rat are susceptible to spotted fever and are also utilized as hosts by the tick. "Tick cycle" experiments, and other experiments with the tick, indicate that at least the first four may, when acting in conjunction with the tick, be effective in maintaining the disease by causing its extension among the ticks.

Should they be destroyed, insofar as this is possible, as a part of the campaign against spotted fever? It is too soon to advocate this on a scientific basis for the following reasons: In the first place, if the number of ticks can be kept down to the "safety point" by the methods already mentioned, their destruction would accomplish nothing so far as spotted fever is concerned. In the second place, the search for those animals which actually suffer from spotted fever in nature has not been completed, and definite recommendations concerning particular animals could not well be made until this phase of the work has been carried farther. If this were to be a final report and the work were to be carried no farther, I should recommend the destruction of all the small animals studied, because of the suspicion which attaches to them as hosts of the parasite of spotted fever. It would, of course, be impossible to exterminate completely any one of these species, but as in relation to the tick their numbers might be kept down to a "safety point" by suitable methods of poisoning.

Although it does not seem justifiable at this time to recommend their destruction as a systematic means of combatting spotted fever, with the consequent expense involved, encouragement may well be offered to the residents of the Bitter Root Valley for their destruction, because of the suspicion which attaches to them.

RECOMMENDATIONS.

1. That the residents of the Bitter Root Valley be instructed in the points brought out in this report and in Report No. 1 of last year.

2. That an active campaign be instituted for the eradication of the tick in areas known to be infected with spotted fever.

It is recommended that the method of oiling the domesti-

cated animals on which ticks are known to mature, be put into effective practice during the period between March 15 and June 15 of each year, the privilege of extending or otherwise altering these limits being reserved. The oiling should be repeated every three or four weeks as experience might indicate. Crude oil has given satisfactory results in the southern states.

Legislation may be necessary in order that the State Board of Health, or other suitable body acting in conjunction with the State Board of Health, may have power to render such a procedure effective.

The feasibility of clearing land in infected districts, which is covered with timber and brush, and the best methods of accomplishing this, should be investigated, and this procedure should be advocated to the owners of such land. It may be that power in this matter could also be conferred by the legislature.

3. That the destruction of the small wild animals, mentioned as being possible hosts for the virus of spotted fever, be encouraged among the ranchers, conditions not being ripe for undertaking this project systematically as a part of a campaign against spotted fever.

4. That additional funds be voted that the work of investigation may be carried to completion.